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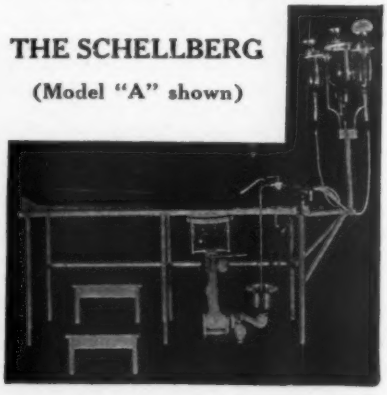

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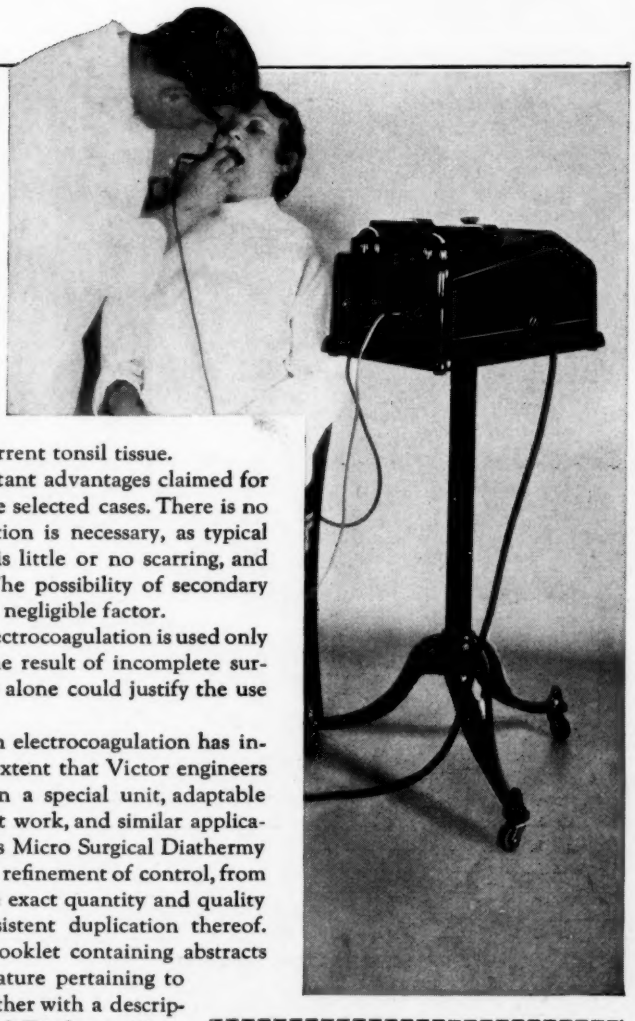

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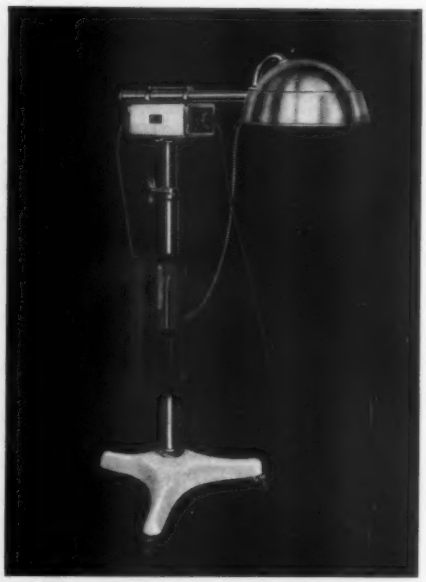

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A CLINICIAN'S IDEA OF ULTRAVIOLET DOSAGE *

NORMAN EDWIN TITUS, M.D.

NEW YORK, N. Y.

In the past three or four years many well known scientific men have presented to the medical profession valuable contributions concerning ultraviolet dosage, its effects and its physics. These reports in the most part have been the work of physicists who have made additions to the literature and have supplied the doctors in general with the entire physical foundation upon which the subject of ultraviolet therapy is based. It is not the purpose of this paper to weigh the merits and demerits of the scientific work already published, nor to discuss any specific dosages of ultraviolet light, but to review the facts as known up to the fall of 1930, as applied to the clinical administration of this most potent form of energy. It is the writer's desire to bring out some pertinent clinical facts which might be of assistance to other clinicians. Be it understood that this is not a paper that will be absolutely incontrovertable perhaps two years hence. One always must realize the limitations of discussions on the use of physical energy. Certain views may be accepted as true at the time of writing but subsequent discoveries may force us to relinquish or modify our earlier beliefs.

The physics of ultraviolet energy is the basic part of the science which will never change, for it is reasonable to believe that the laws of physics, as understood today, are quite permanent. What will vary the consideration of ultraviolet energy will be the biological or bio-physical effects which subsequently will be found on more extensive research.

Clinicians, of course, must know something of the fundamental nature of the energy which they employ in this daily routine of treatment. They never will accomplish anything with ultraviolet radiation in practice by administering it in a slip-shod fashion. Attention must be paid to the physical energy used. There are plenty of journals that publish popular articles for the benefit of clinicians. They make interesting reading especially when one understands the physics and is patient enough to read the fanciful conceptions of the new enthusiasts in the field. You all know the long list of claims made for ultraviolet light which cannot be reproduced by you no matter what kind of a lamp is used. Many pamphlets have been gotten out by manufacturers and as many books have been written on the subject which extol the clinical miracles of this agency. The conservative and well trained physician on reading such blatant material turns away in disgust from such impossible practices and condemns the whole discipline in no uncertain terms. In consequence, many a desirable disciple is thereby lost to physical therapy.

Those of us who are forced by circumstances to devote the major portion of time to the clinical side of medical practice must depend entirely upon the research worker for basic facts. In our use of ultraviolet we must depend, therefore, upon lamps giving exactly the kind of energy we expect.

It will not be attempted in this paper to discuss all forms of ultraviolet energy. The physics of the carbon arc lamp has been thoroughly investigated so that it is now known exactly what the carbon arc lamp will do. But because of some of its mechanical drawbacks, the carbon arc lamp has not enjoyed the scope in clinical use as has the quartz mercury arc lamp. Any electrical arc generates ultraviolet light and a most efficient source of ultraviolet light can be manufactured by the use of two pieces of iron. In fact, in England, Professor Walter J. Turrell of Oxford, places his greatest faith for the accurate administration of ultraviolet light on an arc composed of two electrodes of pure tungsten. He has had such wide experience in the use of this arc that he knows exactly how to standardize dosage with it. Sir Henry Gauvain, famous for his work with actinotherapy in his hospital in England, uses all kinds of arcs, including iron arcs made up of cheap bolts placed head to head. In this coun-

* Read at the Ninth Annual Meeting of the American Congress of Physical Therapy, St. Louis, Mo., September 10, 1930.

try the best one for office and hospital use, especially for the individual treatment of patients, is the mercury arc in quartz lamps. Many names are given to it, such as the quartz light, quartz mercury vapor lamp and others, but essentially it is an arc using mercury as the chief substance which is enclosed in a quartz tube merely because this quartz tube will permit the passage of the ultraviolet rays and keeps the mercury from spilling upon the floor. Therefore, the attention of this paper will be directed more to the clinical use of the mercury arc lamp.

Of most interest to the clinicians working with the mercury arc lamp is the quality of light emitted from the lamp. The quality of light is well known and does not vary a great deal until the quartz tube becomes progressively and sufficiently opaque to the short wave lengths. The light emitted from this burner is in spectral lines and not a continuous spectrum. Sufficient information of these bands has been given us by physicists so that we may appreciate the powers and limits of the light from the mercury arc lamp. The reaction of these regions of light is still a subject for vast research by biophysicists, but we are now sufficiently informed of its biological reaction to be able to use the lamp quite comprehensively and without fear of adverse reactions in the future. Consequently, the evaluation of quality of ultraviolet light is pretty well standardized for clinical use and it is much more necessary for us to pay attention to the quantitative dose of this potent energy.

Physical researches have shown that certain burners are most efficient when a given voltage is passing through the arc. As the mercury heats and the resistance of the arc diminishes, all lamps reach a stage where they burn at a set and regular voltage. In order to insure the quantity of energy emitted, it is necessary that the lamp be burning at its optimum voltage. Consequently, to know when this stage is reached, it is of utmost importance to know the exact voltage that is laid on the arc. Hence volt meters in the circuit are extremely essential. When we have the arc burning at a constant known voltage it removes one of the variations factoring in the quantity of ultraviolet light. With a set standard distance another variation is removed because it always must be remembered that ultraviolet light is true light and that the intensity varies inversely as the square of the distance. Hence if the distance is kept standard, the second variation is removed. Therefore, in the administration of ultraviolet light, if we have constant voltage and distance, our only necessary variation for grading our dosage is time. All clinicians know that mercury arc lamps diminish in efficiency but this diminution is much more in quantity of output than in quality, so that if lamps are watched and checked up frequently, as will be mentioned later, the time factor may be varied according to the need when the exact deterioration of the burner is known.

Viewing the quantitative efficiency of a lamp from the clinical standpoint, we have to depend upon the length of time it takes at a given voltage and distance to produce a skin erythema. Such a unit of dosage is universally clinically accepted. Many methods have been brought forth to estimate erythema dosage. Complicated machines have been produced costing foolish sums of money. Chemical photometers have been introduced which cannot be relied upon as being trustworthy, for in spite of all the claims made for them, one always must remember how the results may be varied by the age of the substance, the humidity and temperature of the air and, more important, the lack of color appreciation in the eyes of some individuals. The most recent colorometric photometer depends upon oxalic acid which must be prepared specially for each test, and also upon the matching of colors. Some men have advocated using direct individual tests upon the skin, and one expensive metallic apparatus has been shown which makes it possible to expose different adjacent areas for different lengths of time. This undoubtedly is the best way to test a lamp when first starting to use it. But it is not necessary to use a fancy metal instrument. All one has to do is to cut a series of U-shaped flaps in a piece of carboard, each making a small opening. Then by exposing all openings, closing them successively until all are shut and giving exposures of ten or fifteen seconds' difference through each opening, the next day the patient's skin will show a series of increasing erythemas; and the time of each exposure being noted, the clinician easily may ascertain what is the erythema time for a lamp at a distance used as a standard.

Professor Turrell, at Oxford, employs a somewhat similar method to ascertain the erythema time of each individual patient, using his pure tungsten arc. He places a piece of paper with a hole about the size of a dime in it over the patient's forearm. Then putting on special glasses of Crooke's "B" glass, he watches the skin through this hole as the light from the tungsten arc is focused on it from a silicon mirror, timing the exposure. When the erythema dose has been administered, the skin exposed becomes much darker than the paper. In fact, it is possible to see a sudden darkening of the skin at the exact moment. Taking the time with a stopwatch gives the exact erythema dose at that distance for the individual patient. This method does not work as well with the mercury arc.

Practically all clinicians using ultraviolet energy are agreed that the most beneficial effects are achieved by the use of a suberythema dose and the increase in time of dosage is usually one-half minute. Some men like to increase the dose by a minute but the majority, as far as can be ascertained, believe in the lower rate.

Another time factor varying the effects of ultraviolet light is the frequency with which the doses are given. It has been the writer's experience that the best way to get results is to give ultraviolet light not more than once in forty-eight hours. Sometimes a stage will be reached where a patient will get an erythema from a dose of, let's say, four minutes during the course of treatment. Then at the next seance the last dose is administered again with no increase and the patient does not get an erythema. The main reason for making this interval of forty-eight hours is this: the entire effect of the ultraviolet energy, in fact the last vestige of erythema, is not acquired until twenty-four hours after exposure, so it must be concluded that until the entire erythema is formed, the chemical reactions in the skin are not completed. Biophysicists are still undecided as to just how and upon what substances these chemical effects are brought about. The feeling in England today is that the American biophysicists are wrong and that histidine is the substance affected rather than cholesterol, as is generally believed here. However, there are undoubted chemical effects and exactly what the reactions are is not so vitally important to the clinician. Granting, however, that these chemical reactions do occur, it is only safe to allow a sufficient interval for that chemical substance to be redeposited in the skin before a subsequent dose of ultraviolet is given. Consequently, it is the practice in the hospitals with which the writer is connected, to give ultraviolet only every other day and to increase each dose by one-half minute.

When a patient has reached an exposure of ten minutes on each side of the body, this is called the end of a series. Treatments then are stopped for a week and, when reinstituted, are started again with a minute exposure. The question often arises why we limit the dosage to ten minutes. There are two reasons, the first of which is most pertinent in a large clinic and that is, that a patient getting more than a total exposure of twenty minutes takes too much time in a busy clinic. Some men give dosages up to forty-five minutes on each side of the body, working up progressively and not stopping until the patient for some reason of his own must discontinue treatment. Such treatments in a busy clinic or office, requiring an hour and a half's use of a lamp, are economically wasteful and physiologically useless. It is well known in the use of ultraviolet energy that to activate foods a certain dosage is the optimum dose forming the greatest amount of vitamine "D" in the substance irradiated. When more than that amount is given the amount of vitamine "D" formed is less than when the correct time is given. This is spoken of as, but is not truly a reversal in action. Time will not permit more detailed exposition of this interesting phase of the problem.

Reviewing many hundreds of patients treated years ago, it was found that the patients who had one or two series terminating at the end of ten minute exposures did better than patients who continued on to long, excessive doses of ultraviolet radiation. Consequently, from a time-saving viewpoint and still not losing any physiological result, it has been our plan to terminate each series when the patient receives ten minutes of ultraviolet light on each side of the body.

Such treatments as stated above are for purposes of general tonic effects. When it is desired to bring about other effects, of course, the time factor must be varied. For instance,

in the treatment of extensive burns, ultraviolet light alone, given in any appreciable dosage, does not accelerate the formation of epithelium. Experience has taught that in these cases one must combine continuous radiant light with ultraviolet radiation, the latter to be given in two doses per week, twenty seconds each at twenty-four inches in order to accomplish its stimulating action on the skin. A dose such as this, given to a denuded area immediately before skin-grafting, stimulates the underlying tissue sufficiently so that a skin-graft "takes" in a most admirable way.

There are a few occasions when an intentional erythema is desirable. In the treatment of erysipelas, we find that doses producing strong erythema reactions provoke much better results than other forms of treatment. Psoriasis can be benefited greatly by very strong erythema-producing doses but, as with acne treated in the same way, the results are seldom permanent. The beneficial results in psoriasis are nevertheless sufficiently striking to have it included as a useful adjuvant.

There is an action of ultraviolet light in causing a limited pronounced erythema that has been made use of and published by Bannerman, who works with Sir Henry Gauvain in London. Bannerman found that exposing small areas of the body to the mercury lamp and causing a pronounced erythema had a definite effect on increasing immunity. This phenomenon was elicited in the laboratory on many animals, but as yet no striking parallel has been found in relation to man.

It is thoroughly understood that ultraviolet energy will produce tanning of the skin, but it is not understood so generally that tanning of the skin is a distinct aid in the action of ultraviolet light. Melanin, the substance which is deposited when the skin is tanned, changes the wave length of ultraviolet light, allowing the energy to be conducted through the most superficial epidermis into the deeper layers. Consequently the energy is better utilized. The general belief seems to be that tanning is a reaction to protect the body from ultraviolet light; as one might say, pulling down a shade. This, however, is not the fact. It merely converts the energy into a more penetrating form. Experiments with all kinds of light have shown that more energy passes through a negro's skin than through an untanned skin.

A rather interesting use of ultraviolet light is being made by the surgeons at the Presbyterian Hospital in New York, where some of them are prescribing it as a routine postoperative treatment in order to shorten the convalescent period. The work is too premature to draw any positive conclusions, but it seems that such a procedure is in line with correct treatment.

As stated, at the Presbyterian Hospital it is the usual procedure to use a standard distance of thirty inches. The most ingenious way of keeping that standard distance, originated by Miss Margaret Eliot, one of the supervising nurses of the hospital, is to attach a piece of electric light pull-chain to the side of the lamp and then lower the lamp. Measuring the correct distance with a yardstick from the burner to the skin, this chain is clipped off at the exact small section. Thereafter, as the lamp is moved from bed to bed, it is only necessary to lower the lamp until the chain touches the patient. The chain is then thrown over the top of the open hood and the treatment given. Treatments are not given until the voltmeter on the lamp shows that the burner is working at its correct voltage, which, in the model used, is seventy-five volts. The doses are started at one minute and increased by half-minute intervals on the front and back of the patients.

It is interesting to note that the absorption of ultraviolet energy can bring about effects on the endocrin glands. For a period of over one year at the Presbyterian Hospital we carried on a series of investigations in an effort to determine what, if any, was the influence of ultraviolet exposures upon menstruation. The experiments were made upon healthy nurses and the results were so variable that no definite conclusions could be drawn except that it was deemed advisable not to administer ultraviolet light during the menses, as such procedure frequently causes marked pelvic pain. The only other definite conclusion that could be reached was that ultraviolet light given during the menses would change the schedule and frequently would cause unnecessary worry as to the possibility of pathology.

The exact method of keeping record of the dosage is as follows: A fraction is made on

the chart, drawing two lines diagonally across the space on the temperature sheet and the numerator shows the number of minutes given on that date and the denominator shows the total number of minutes including that day's exposure. Consequently, on the first day's record we have a fraction of 1//1; on the second day 1½//2½; on the third day 2//4½. Thus the denominator is always the total of the previous denominator plus the numerator of the present day. When a total of ten minutes is given, which completes a series, the patient has had 105 minutes on each side of the body, or a total of 210 minutes' exposure to the lamp. This method of record keeping has given no trouble and when the time comes that investigation is wanted into the effects of ultraviolet light, such exact records of dosage will be of undoubted value.

In order that the dosage may be correct as stated and the quantity of energy that is emitted is standardized, it is more essential to accurately estimate the output of the lamps in use and keep records of their efficiency than to try out erythemas on patients who may vary in their reactions. At the Presbyterian Hospital each lamp is tested quarterly and its quantitative strength in erythema units is recorded. To do this work use is made of a photometer utilizing a sodium quartz photo-electric cell. This was originally made by Professor Burt of California and has stood up against all other photometers as being the one least affected by personal equation. The results are obtained through the action of the light on the cell which causes definite galvanometer readings on the apparatus.

This photometer has been used to test out lamps since April, 1927, and some interesting figures have been obtained with which I shall not bore you in reading entirely. It is interesting to note that in one of our lamps checked up every ninety days, there has been a loss of efficiency of 43½% since the lamp was first installed in April, 1927. It is only fair to state that inasmuch as we have many lamps this one has not been used very much since it dropped below 66% efficiency, but it has had fair usage. Our hospital service takes care of nine floors and we prefer to leave the lamps on each floor when possible for the day's work so that they receive the minimum amount of transportation.

It is unnecessary for me, I am sure, to mention the point that everyone knows that the burners should be cleaned every day they are used. This is best done with carbon tetrachloride or alcohol. It is worth mentioning that in one of the hospitals in New York the director of the department told me that a technician had reported that her lamp would not produce an erythema although she cleaned it with alcohol each day. On examining the lamp it was found that the adulterant in the alcohol was of such a nature that it caused the burner to look like ivory instead of clear quartz. Therefore ordinary alcohol cannot be depended upon as a reliable cleaning agent.

As well as cleaning the burner it is also necessary to be sure that the reflector of the lamp is cleaned. A distributor had a lamp turned in that had been in use for over two years, the reflector of which the doctor evidently had never cleaned. When tested by the Burt photometer, it was found that the erythema time was cut down seventy-five per-cent before the reflector was cleaned.

In the solarium at Vanderbilt Clinic, where four lamps are placed sixty-three inches from the patients, irradiating eight tables at one time, they gave a standard erythema dose on each table in two and a half minutes. During one vacation period when another technician was in charge and preferred to burn one lamp on account of the heat for the few patients who were in attendance, subsequent tests showed that the erythema time of this one lamp was increased from seven to twelve minutes. In treating patients subsequently, it was necessary to keep this lamp out of the circuit until the others deteriorated sufficiently so that each lamp produced the same quantity of light.

The Burt photometer has been found quite dependable in our work, always letting us know the quantity of the energy which could be produced. It will not, however, work with carbon arc lamps because the light emitted by these lamps is so unsteady that the action on the photo-electric cell causes the galvanometer to fluctuate so that it cannot be relied upon.

The writer hopes that this general discussion of clinical views on ultraviolet dosage will be an aid in standardizing biological effects. It will be a long time before more accurate biological knowledge of ultraviolet light will be obtainable as applied to human

beings. It will only be through unified clinical observations and correct record keeping that we shall be able to sometime predict the exact amount of ultraviolet energy that will cure rickets, affect anemias and produce other well known results desired. The physicists will always be dependable men to guide all research, the biophysicist will help in correlating physics with such biological effects as he is able to observe. The clinician should help the biophysicist and make his work contributory towards a better understanding of this kind of therapy so that in the end the clinician will be able to do better work. All our efforts point towards more effective alleviation of human suffering and all the physical properties of our lamps will not be so effective until the clinicians can contribute their part to the general picture of more perfect actinotherapeutics.

Discussion

Dr. Luther A. Tarbell (New Haven, Conn.): I want to congratulate Dr. Titus on the practical trend of his paper. While the majority of us are able to obtain information of a theoretical and biophysical nature, our greatest difficulty has been to find published material that presents the actual experiences of the clinician. The problem of dosage in phototherapy is of great importance to all practitioners and should be discussed more often in this Congress.

I was very much interested in the presentation of a paper yesterday which drew our attention to the variation of physiological effects, particularly upon the blood stream, caused by changes in the quantity and quality of ultraviolet light, particularly its effect on blood calcium and system in general.

One point that was emphasized was that exposures from an erythema and one-half dose was productive of stimulative effects, and irradiations beyond that point resulted in toxic effects. Quantity and quality of dosage plays an important physiologic rôle. Successful phototherapy is dependent upon a thorough knowledge of the condition under treatment but also complete experience of the technic and the biophysical reactions of the lamp utilized. The very simplicity of the treatment has provoked a popular adoption of phototherapy by lazy and uninformed physicians, masseurs, beauty parlor experts, lay people and large groups of borderline practitioners. The abuse of this privilege has resulted in a loss of faith in its properties.

I appreciate the practical value of maintaining a constant check on the energy output of quartz mercury lamps. The scheme of measuring your distance is a very ingenious one. Its very simplicity should appeal to all of us.

The work which he has done with the Burt photometer for checking the mercury arc is very interesting. I wish that we might devise, or some physicist might devise, some accurate way in which we can equally apportion the dosage from our carbon arc light.

In regard to the pigmentation, my view is a little bit different from that expressed by the essayist, and I should like very much to hear from Dr. Bachem on that point. As I understand pigmentation, while it does not necessarily alter the absorption, it does effect in some way the chemical activity of the irradiated tissues. For instance, the effect on cholesterol and some other products is decreased by pigmentation as well as probably some of the other chemical effects. It takes larger doses to produce the same effects in colored people than it does people who are less pigmented.

Dr. H. D. Holman (Mason City, Iowa): The majority of phototherapeutists use their lamps in an empirical manner and seldom take the time to keep records or maintain technicians to do that for them. Nevertheless our results compare very favorably with those who are more meticulous in their method. The reason for that is that we obey the basic laws of photophysics and biology. Most of my patients are started with minimal dosage which is increased as the need for reaction presents itself. From an empirical point of view experience is our best teacher, but unfortunately most of us are rather dull pupils in that school and fail to profit by our schooling.

I should like to see some tests developed that would depend less upon clinical observations and arbitrary empirical standards than that advanced by the majority of present day writers on the subject. Under the circumstances I fail to see any reason for adopting a ten minute maximum standard treatment or any other standard that cannot stand the test of laboratory analysis. I have no knowledge of any such test being in existence but if such a test could be developed or has been, it is the superior to the method of Dr. Titus.

Until such a situation presents itself the therapeutics of photo-radiation will remain just as empirical and probably as chaotic as it is today. Fortunately the benefits resulting from present day treatment is so apparent that it is sufficient justification to carry on in spite of our limited knowledge. I personally have found actinotherapy to be of great value in a host of different conditions and it has made my practice more pleasant and my results more certain. Dr. Titus has contributed a thought provoking paper and no doubt will be a stimulant in the right direction.

Dr. H. C. Polmer (New Orleans, La.): The clinicians will appreciate the salient features brought out in Dr. Titus' paper. There are already enough variants in therapeutic administration of tonic ultraviolet radiation, and we are glad to welcome a constant voltage operation of our lamp, and a constant distance, the only variant being the time.

In cleaning our lamps we have a special bottle of 95 per cent chemically pure alcohol which we

use for our lamps and nothing else. Sometimes our hospital druggist tells us that we wash our lamps quite a bit, because we use up quite a bit of alcohol.

As far as pigmentation, that is still a problem which we are not all clear on. It is possibly a good idea, after you have given what you consider an optimum of dosage, to allow a certain time to elapse between treatments for certain physical, chemical reactions to take place. As far as pigment goes, perhaps you may want your patient to depigment.

An observation made by many in our section of the country, down South in New Orleans, is that when we have some of our real dark-skinned negroes migrate to Chicago or to New York where they do not get a lot of caloric radiation, and when after six months or a year or more they come back to us, they look very much lighter. I should like to know if the physiologists have seen this depigmentation occur?

Many of our female patients come to us for general treatment. They take a bath and daub themselves all over with their favorite dusting powder. This acts as a screen. We tell those patients, "Yes, lady, please bathe, but don't powder."

Dr. Albert Bachem (Chicago, Ill.): I was particularly interested to hear "A Clinician's Idea of Ultraviolet Dosage" because as a physicist I seek frequent opportunity to keep in close contact with the medical profession and particularly to get interesting suggestions from an authority like Dr. Titus about ultraviolet light.

I am particularly interested in the subject as related to be able to do the physical action of this energy. The real problem is to corroborate physics with clinical work. As far as Dr. Titus' paper is concerned, I have to appreciate how Dr. Titus distinguished between the quality and quantity, that either the quality is kept constant and the quantity measured, or the quality is measured by spectrographs, and so on, and the quantity is kept constant. The greatest difficulty, however, in the question of dosimetry would be to measure both factors at the same time, just the same as in dosage in other applications we have to measure milliamperage and voltage at the same time, and have to measure the wattage. That is what has not been entirely solved at the present time for ultraviolet work.

As far as present dosimeters are concerned, I agree that the Burt photometer is the best on the market and is one that actually is useful for controlling measurements on the lamps that one uses.

I have had a similar experience to that of Dr. Titus, that lamps being used over a long time lose something like 20, 30 or 40 per cent of the ultraviolet and active rays. Those things can be easily determined by Burt's photometer.

There is one thing that makes Burt's photometer rather difficult in its use, namely that a number of filters are provided, and these filters limit the transmitted spectrum just from one side. So one has to make a number of five or six measurements and figure out the difference between one and the next one, and that gives us, then, under certain mathematical precautions, the idea of the intensity of a certain limited spectrum range. It is rather tiresome to make those measurements. It is inaccurate to figure out the difference because small errors show up in the difference much more than in the singular measurement. Altogether, an instrument for clinical and practical use should be as simple as possible. This is one of the present disadvantages of Burt's instruments.

Another difficulty might be that the filters used change under the impact of ultraviolet rays. We say that they get tired; they don't transmit the same amount. So we would even have to control the filters after a time. This, of course, is the worst thing that can happen to an instrument, that the instrument isn't even constant, and we have to find out another way to control the instrument.

Finally, I should like to say that I have had experience only with one Burt instrument. In order to know how well those instruments are standardized, one instrument comparable to the other one, one would have to compare about five or six instruments and see how well they compare. It happened that on the instrument I received from Burt, the red line was missing which is necessary to control the constancy. I wrote to Pasadena but didn't get any information, so that I can only use the instrument for the control of my own apparatus and not for any standardizing measurements.

Dr. Titus brought out the importance of dosage. We have heard quite a few remarks at this convention about how little we know about dosage, and how much we want to know, because there are lamps with low output and lamps with high output. The question is whether the lamp should be returned to the company to have the burner exchanged for a new one, and so on. I should like to mention in this connection, that in the Hanovia lamps we are using, by pressing the button on one lamp we increase our intensity three to four times. On the other lamp, by pressing the button we practically get no difference. Those are items that we have to determine. Of course, we determine those practically by our clinical observations, but they are not as accurate as those physical measurements would be.

As to the question of erythema dose, I think Dr. Titus mentioned that an erythema dose can be determined but that it is not as uniform as we should like to have it. I happened to make experiments about a year or two years ago in which I applied exactly the same amount of ultraviolet light by a Kromayer lamp and under the same conditions to 100 normal and 100 abnormal patients. The result was that in a great many of the patients the time of the appearance of the erythema varied between four and twelve hours, and in certain cases it did not show up at all. By the use of the erythemameter, which was suggested by German workers and was built by myself, I found that the ratio along a certain intensity scale, which did not mean very much, was about one to three.

We then figured the product or the quotient and determined the sensitivity exponent of the skin and found that this exponent varied in a ratio of about one to ten. This distinguishes the ultraviolet erythema dose very strongly from the x-ray erythema dose, which is in much closer limits. Then with ultraviolet the other item comes in that was mentioned by Dr. Titus, that on the second day we can give one-half or one minute more, and the third day so much more. This points to the fact that certain skin must be more accustomed to ultraviolet than other skin would be.

So far as the biological effects are concerned, we have to strive for an instrument that measures ultraviolet as far as quantity and quality is concerned, and at the same time will enable us to measure possible erythema doses. Then we have a talking point, and we have a chance to compare our physical and our biological effects and come to the conclusion that we are looking for, namely, to determine sensitivity of the skin, and so on.

As far as pigmentation is concerned, I think we have to consider three items. I am not ready to talk about it and I do not have the time. The first thing is reflection. That seems to me one of the important items, because we see right away, from looking at white and colored people, how immensely different the reflection is. That is something that has to be determined, and it has been determined by two very prominent men, by Dorno in Switzerland and by two German workers, on the various races, and so on. So most of those questions have been answered; however, more in the visible than in the ultraviolet part.

Then comes the penetration. I agree with Dr. Titus that generally speaking there is as much light entering the negro skin as the white skin, but if it comes to a distinction between ultraviolet and visible light, then it becomes much more complicated.

Finally, the absorption in the various layers. This is an item that is of importance, and one that Dr. Reed and I are particularly working upon at this time.

Dr. Norman E. Titus (New York City, N. Y.) Closing: Dr. Tarbell speaks about varying the distance, and not using something to measure the distance. That is just one of the things that I tried to stress, that if you keep the same distance with each patient and you know exactly what it is, then you can vary your time according to the way your lamp deteriorates, or according to what you want to do with it. I think if Dr. Tarbell and I laid alongside each other on the table, you would find that I would be much nearer the lamp. If you dropped the cord connected with the lamp so it touched him, we might get the same dosage.

Dr. Holman mentioned colds. I have been making observations on this condition for about eight years and have found that if somebody has an acute coryza and is given a strong erythema dose of ultraviolet (if your erythema dose is three minutes, give them three and one-half), it will ward that off.

Dr. Polmer spoke about using Louisiana alcohol for cleaning. I think he might as well continue getting the alcohol and use carbon tetrachlorid.

Dr. Bachem spoke about the photometer. We realize the limitations of our attempt at present to be exact in our dosage. We have used the same photometer for a number of lamps. I have twenty-eight lamps, and that same photometer has been used for two and one-half years, each ninety days on these twenty-eight lamps. So we have an approximate idea. It isn't as scientifically exact as you would like, but it is the best thing we can do to vary our time. If our efficiency is down 33⅓ per cent, we vary our time. When it gets down below that we ask for a new burner. Each technician has her own lamp. We try to have as much standardization as is clinically possible. We have to allow for certain individual variations.

With the pigmentation I have always understood that when you get fluorescence, there is change in wave length. I say to my students, "When you get tanned, you don't get sunburned. When you get melanin deposits, evidently something has happened to let the ultraviolet light slip through that portion of the skin and not be stopped. So you do not get a real ordinary sunburn."

ADVANCES IN ELECTROSURGERY *

PART I

HOWARD A. KELLY, M.D.
BALTIMORE, MD.

As often as I have recourse to electrosurgery, I long to dock thirty or forty years from my life and begin again, convinced as I am that electrosurgery is born to introduce a new era, even if of a minor order in our ancient specialty. This conviction is forced upon me by the accomplishments already effected as well as by a growing familiarity with the subject which suggests that much more lies hidden in the womb of the future yet to be developed by new hands than anything so far revealed. In other words, it is my hope that we are on the eve of an era of profitable exploitation of this still youthful field. May we not then consider it our function at this gathering to emphasize the undeniable paramount importance of this new agency as a surprising, utterly unexpected, and novel power destined to the attainment of objectives in the surgical field hitherto beyond our grasp. May we also in a measure foster our belief that electrosurgery is not merely an occasional preferential method of reaching sundry ends in the surgical field but that it is obligatory and that in its concurrence (if you will permit the Gallicism) it reaches its goal with greater dispatch in a far neater, less messy, and therefore better way than the ancient scalpel-ligature procedure.

I begin by urging that we one and all expand the field of electrosurgery by putting it to wider uses, even where the presumptive advantages are not obvious, in order to achieve that spontaneous *finger-fertigkeit* which passes into a second nature, an instinctive habit, a sort of subconscious electrosurgical sense that paves the way for and conducts readily into new fields wherein lies hopes of surprising discoveries.

I further indulge a hope that our varied experiences as related this evening may open some doors to a yet wider, more aggressive, and more successful surgery: I refer to fields where the scalpel and ligature have failed in efficiency as in operations on the head, the chest, and the neck, advancing into the depths, awkward in their performance and involving delays, manipulations, and a probable contamination, with undue hemorrhage; cases in which we often try to counteract the soiling of the wound by free drainage; a group dreaded on account of that uncertain point at which we are likely to meet the *ne plus ultra* barrier. Who does not recall also the time-consuming attempts to check a troublesome hemorrhage by tight wad packing, with shock and lessened vitality and subsequent inflammatory sequelae with an expectation of the one time "laudable pus."

Grant me a minute to appeal to those in our audience with but a slight practical knowledge of electrosurgery, while I briefly enumerate its advantages: It is a tremendously effective sterilizing agency; it does clean work of a supreme order; it is a knife and fork procedure, avoiding finger contacts and leaving a delectable dry, smooth field; it is rapid; there is less shock, followed by a comfortable convalescence with fewer inflammatory sequelae; it is, therefore, far less formidable, and our patients are oftener ambulant, thus enlarging hospital bed facilities.

Whenever I discuss this astonishing novel agency which but a few years ago took us by surprise, I feel an irresistible urge to pay tribute to our friend William Clark, recognizing his priority and thanking him for his conspicuous labors in bringing this field to its present perfection. That certain steps were antecedent is true here as in every important discovery, a fact curiously enough tending to arouse a horde of disputants. Rivière, the great pioneer, followed by Doyen, an erratic genius, held and published the truth, but the profession failed to appreciate their labors. It was Clark who struck the novel path and stuck to it with praiseworthy zeal until he forced the world to follow him and placed hundreds of machines in the hands of our surgeons everywhere.

* The papers of Drs. Kelly and Ward were presented as a symposium on electrosurgy before the New York Physical Therapy Society, January 7, 1931.

Then, there is also the cutting current, which I call "acusection" cutting with a needle or a small flat blade. This, which at first appeared to be but a novel way of dividing the skin and checking any bleeding, insuring fairly well the primary union of its sterilized margin, has expanded until it affords us the means of making extensive rapid dissections in a dry field, while beautifully barring vessels and nerves. As an old anatomy prize man and demonstrator in dissecting rooms, I find it hard to express my full appreciation of this novel instrument. Let us not omit, then, an occasion to pay a debt of affection and gratitude to our friend George A. Wyeth for this precious *addendum*.

You will have noted a growing tendency to replace the tubes and use spark gap machines for cutting on account of the convenience in size and portability and the greatly lessened cost, thanks to the efficiency of our able coadjutor-makers of fine electric instruments. I would here ask those who follow to inform us whether they have noted delayed healing of the skin wounds made with the damped current; Ward and I have been greatly interested to see whitened edges so uniformly heal *per primam*.

Further effective fields are found in combination with general surgery and with radium. We often fail surgically in dealing with malignancy in one or two small areas; there arises then the serious objection to any further aggressive efforts with scalpel and sutures. The difficulties are the more formidable when the recurrences lie well in from the surface. Electrosurgery steps in at this point as a comparatively simple speedy adjuvent in the treatment of the lesion *in loco* by coagulation, followed either by curettage or by letting it separate to be discharged spontaneously. Radium, on the other hand, is sometimes of value in shrivelling up a large lesion to a point where it can be more effectively attacked and destroyed with the current. Where radium has failed to cure and the treatments cannot be pressed further because of the induration, lowered vitality, and extreme sensitiveness of the parts, electrosurgery comes to our aid by extending the field and wiping out the sensitive area and withal bringing peace and comfort. I recall a case in point: Huge ulcerating surfaces due to radium, occupied the left lower abdomen and anterior aspect of the left thigh; the brawny depraved tissues had formed a foul sloughing mass, the seat of constant intense unendurable pain. An electrosurgical knife and fork operation, cutting well out into the surrounding sound skin, with an extensive undermining, cleared up the whole affected terrain down to the deep abdominal fascia and at times below it, almost no ligatures being used. Instead of a repulsive piece of scalpel surgery, it was most interesting and stimulating throughout. The new, clean area was treated with 5 per cent mercurochrome and suitably dressed. Granulations as usual set in early and about one hundred and fifty grafts were placed by Ward. The entire wound healed in a few weeks, while there was a blessed relief from the day of the operation.

I would remark here *nota bene* that grafting and flap work are destined to receive a fresh and powerful impetus from this agency. Doctor Ward will show a beautiful piece of plastic surgery where he has taken a large flap from the neighborhood and covered in an extensive face defect with an admirable cosmetic result. Both of us are anxious to hear from our hosts of any extensive nevi removed and grafted.

It is evident from Cushing's and Dandy's work that there is a large field for electrosurgery in brain work (and in spinal cord work as well), where it controls the ever troublesome hemorrhage while destroying malignancy *in loco*.

Perhaps at the present writing, there is no more novel, striking, and effective field for its services than in extensive face lesions extending inward over the nasal mucosa and the oral surfaces, often involving an antrum as well. Personally, I am more impressed by this than perhaps by any other operation, as I recall vividly my student days when these procedures by the best surgeons were so uniformly bloodily spectacular and futile. We have jointly handled some of these cases which will appear shortly on the screen, and I therefore leave the details to Doctor Ward, with the recognition of the value of his services and cooperation and with the remark that I habitually turn to him for advice and cooperation in difficult work, both of us having drawn our primal inspiration from William Clark and George Wyeth.

There is an important field developing, I

think, in the complete devitalization and destruction of metastatic glands *in situ*, a procedure which calls for careful study to determine just how far we should go to avoid all risk of recurrence. It not infrequently happens after a bold surgical effort that one is forced to realize its distressing futility upon discovering that there are one or more outpost enlarged glands which should be removed, while the condition of the patient forbids further delay and dissection. The electrosurgical puncture thoroughly cooking the gland, I believe, will always meet our need promptly, speedily, and efficiently, whether it lies above the lesser curvature of the stomach or in the crotch of the mesenteric vessels or along the pelvic brim or on the pelvic floor.

It is now over thirty years since we attempted at the Johns Hopkins Hospital to bring our pelvic extirpations for carcinoma into the category of the radical Halsted-Meyer axilla-breast operations, by dissecting out both groups of pelvic glands on the floor. Such procedures lasting for hours and proving formidable in their immediate sequelae furnished lamentable statistical results. Now all may be changed, for the gland destruction is but a matter of a few minutes without hemorrhage or dissections; the only question remains is how well are we assured against recurrences.

I have found particular pleasure in using the coagulation and cutting current in radical breast operations without a single ligature. The duration is, I think, much shorter than the average operation. Personal experiences induce me to praise highly in this field the extirpation of massive malignant, especially ulcerative breast carcinomata, without the hope of doing more than removing the unsightly troublesome growth and adding substantially to the patient's comfort. I have found that we sometimes here get far more than we had dared to hope for in the way of improvement and prolongation of life, and that there may even be an apparent cure for a considerable period.

It has recently fallen to my lot to remove extensively adherent carcinomatous uteri with a liberal use of the cutting current in a dry field. In one instance, a scirrhus implant in the bowel wall was neatly dissected out and the involved area inverted; this has been followed up by heavy radiations during the convalescence.

For kraurosis and for carcinoma of the vulva and clitoris, there is no other method comparable to circumvallation, forming a white zone of heavy coagulation on all sides, followed by the removal of the structures with the acusector. Then either the whole wound is left to heal by granulation or the tissues are united in part to lessen the denuded surface.

As in all malignancy, periodical follow-up work is imperative, in order to catch recurrences while yet small and well localized.

Doctor Ward and I are jointly interested in one of the cases shown on the screen; the others are exclusively his own work.

ADVANCES IN ELECTROSURGERY

Part II. Extensive and Inoperable Malignancy

GRANT E. WARD, M.D.

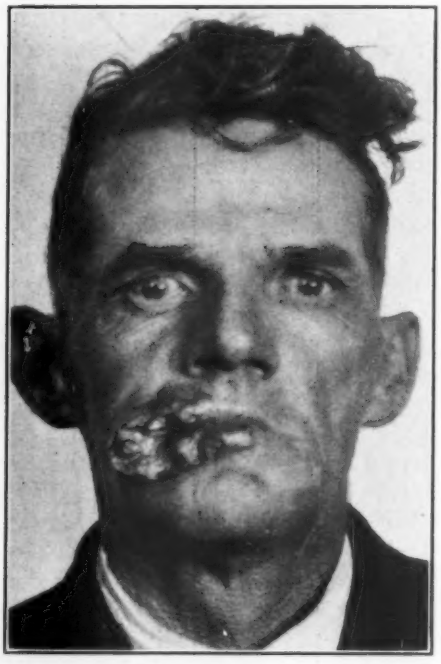
BALTIMORE, MD.

Part one has been devoted to discussion of the progress made in the electrosurgical field. This second part is a display of a few extensive cases of malignancy treated by combined methods of irradiation and electrosurgical removal. Comments are made as the cases are described, emphasizing important features of treatment.

Figure 1: Mr. S. V. was first seen by us March 9, 1925, with an extensive squamous cell carcinoma eroding the right cheek about two-thirds of the way back from the angle of the mouth, without enlarged glands. The first treatment was by the implantation of radon seeds, followed by heavy external irradiation.

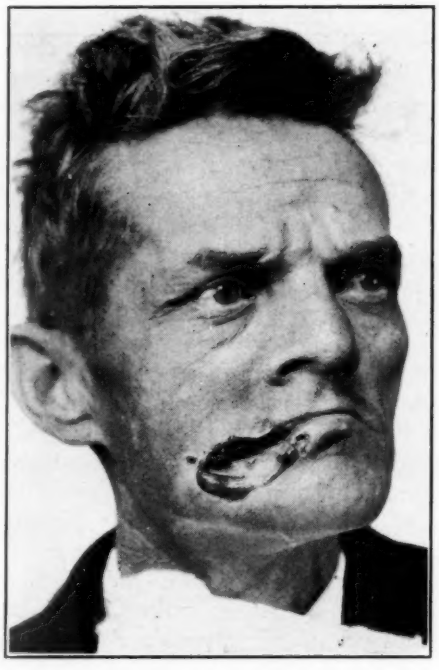
Figure 2: Shows the same patient when he returned for further treatment, May 6, 1925. The fungating, cauliflower-growth had disappeared and the skin and mucous membrane edges almost grown together. The edge

Fig. 1



Extensive squamous cell carcinoma, eroding right cheek and angle of mouth (March 9, 1925).

Fig. 2



Same patient following radon implantation (May 6, 1925).

of the defect, however, consisted of a dense rim of induration about 1 cm. in thickness, feeling harder than the induration of radium scars, suggesting the presence of lingering growth. Biopsy with an electrosurgical current preventing dissemination of malignant cells revealed groups of cancer cells trapped in the dense scar tissue of the irradiation, calling for radical treatment.

Under general anesthesia, electrosurgical excision was accomplished and the outer portion of the lower jaw thoroughly coagulated to destroy growth adherent to the periosteum. A small, hard gland which had appeared beneath the mandible, was thoroughly coagulated and left *in situ* to slough away. The patient made an uneventful recovery from this operation without pain and returned to his home in Virginia for two or three months.

In the summer of 1925, he returned with a few suspicious-looking granulations at the lower side of the wound. These were treated with unfiltered, glass radon seeds. Following this treatment there was a terrifice painful reaction from radium periostitis, confining him to bed for about six weeks. This is in marked contrast to the painless convalescense following the electrosurgical excision. He recovered from this reaction, however, and has been clinically well since.

Figure 3: Taken on May 12, 1927, shows excellent healing with a portion of the right lower jaw remaining. A plastic operation would close the defect, but the patient has refused this. He is comfortable and able to work and support his family and does not mind the unsightly appearance.

The striking features of the case are:

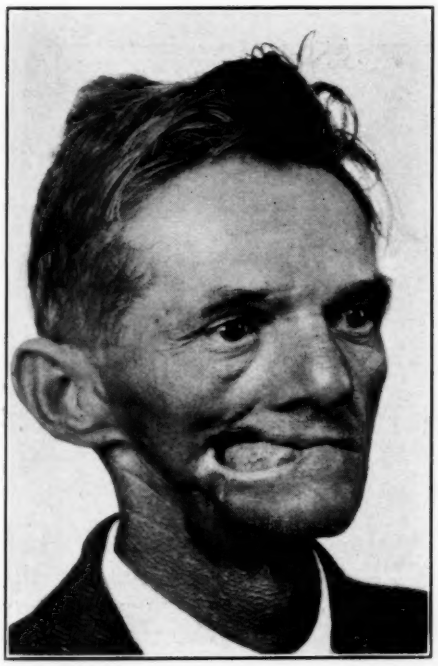
1. The importance of biopsy, even in the presence of apparent healing following irradiation. This is a relatively safe procedure with electrosurgery.

2. The value of combining radium and electrosurgery. Whenever possible radium should be administered first, and electrosurgical operation performed in from five to seven days, preventing the slowly-healing, painful slough with consequent cachexia and delayed convalescence. In this way two therapeutic agents are employed.

3. It is possible to completely sterilize a portion of bone which is involved by cancer with electrosurgery, allowing sequestration, leaving the rest of the bone, preventing unnecessary deformity.

Figure 4: Mr. J. L. H. was referred fol-

Fig. 3



Same patient showing excellent healing results following electrocoagulation of periosteum of lower jaw (May 12, 1927).

Fig. 4

Extensive squamous cell carcinoma of left side of nose, left cheek, turbinates and vomer.

lowing efficient x-ray and radium treatments with an extensive squamous-cell carcinoma beginning on the left side of the nose, and progressing until most of the nose and part of the left cheek had been eroded away. The anterior portion of the vomer and all of the turbinates were involved, as well as the roof of the mouth and the left antrum. The center of the cancerous cavity was filled with a large amount of grayish slough, so offensive that it was difficult to persuade the hospital authorities to admit him on account of the objection of other patients. We knew, however, that within 24 hours we could clear up the odor and make the patient much more comfortable. Although treatment was directed at palliation, the end result surpassed our expectations.

Under general anesthesia (interrupted ether) as much of the growth as possible was removed with a wide margin, using a strong, electrosurgical current, which had coagulating as well as cutting properties, and the remainder destroyed and left to slough away. The upper third of the lip was sacrificed as well as the anterior portion of all the turbinates and the vomer; the laft antrum was broken into and all the growth removed with an electrosurgical curet. The hard palate had been eroded in many places, necessitating entering the oral cavity. Feeling that too much destruction of the roof of the mouth would make swallowing difficult, and defeat the aim of palliation, the remainder of the aveolar arch on the left side was implanted with radon seeds.

Figure 5: Was taken 12 days after operation. The wound is covered with a clean coagulum, preventing implantation of tumor cells, a safeguarding feature of electrosurgery.

Figure 6: Taken six months after operation. As the patient lives in Florida he could not be watched at frequent intervals. Had he been close to hand, his cachexia could have been avoided. When I last saw the patient, following the first operation, I felt sure that he would not return, but to my surprise when he presented himself in December, 1929, I could find no evidence of lingering carcinoma. At the edge of the wound in the left cheek there was a little suspicious indurated area, which, however, on biopsy proved to be inflammatory in character. Inasmuch as he lived at a distance, I gave a prophylactic treatment with radon seeds at this point. As the picture illustrates, there was a large amount of

Fig. 5

Same patient, 12 days later, following extirpation of growth by electrocoagulation and electrotomy.

Fig. 6

Same patient, December, 1929, cachectic but without any evidence of carcinoma.

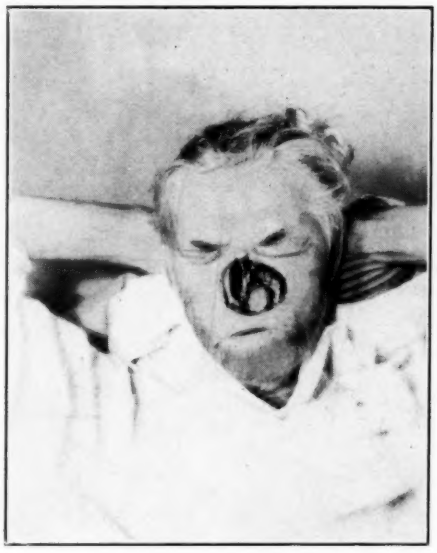
sequestrating bone to be removed. These thin plates of dead bone came away readily, allowing the escape of large amounts of pus from the right antrum and ethmoid cells. The presence of this pus, no doubt, was an important factor in causing his cachexia, together with the inability to eat solid foods on account of the absence of the hard palate. The masseter muscles were partially ankylosed. Under general anesthesia the sequestra were removed, the muscles of mastication stretched, and at the same time a dentist made a composition plate covering the defect in the roof of the mouth. There was one remaining molar tooth on the left side and two on the right, the only possible fixed points for hanging the plate.

Figure 7: Shows the condition after removal of the sequestra and the insertion of the upper plate. The patient was then to go home with instructions to keep the wound as clean as possible and eat all the good nourishing food he could.

Figure 8: Same patient, July 7, 1930. Surprising as it may seem the patient returned, having been able to work for many months. He was free of pain and had gained 45 pounds in weight and was without evidence of existing carcinoma. I never saw such a remarkable change in any individual who had been so near death from carcinoma. The only complaint then was the dryness of the nasal passages, due to exposure of the mucous membranes associated with considerable discharge from the ethmoid cell. The topical application of a solution of ephedrin in oil relieved these symptoms, making him very comfortable. Note in the photograph the presence of the upper plate and the opening into the right antrum, the left antrum being practically destroyed.

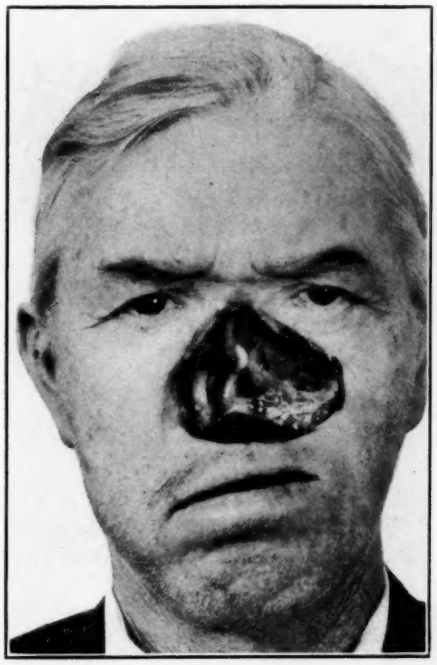
This patient illustrates what can be done by extensive electrosurgical operations, when one thoroughly destroys the growth irrespective of cosmetic results. This patient's health could have been restored more rapidly had a preliminary gastrostomy been done to have kept him in good nutrition during the convalescence, as will be illustrated by one of the following cases. I would like to call attention, also, to the need of careful post-operative attention to infection and the removal of sequestra as soon as possible. Had this man been close at hand he would not have become as cachetic as illustrated in Figure 6, for the infection would have been controlled by the

Fig. 7



Same patient after removal of large amount of sequestrating bone and administration of radon as a prophylaxis.

Fig. 8



Same patient (July 7, 1930) has gained 45 pounds and is free from pain and cancer.

removal of the sequestra for drainage of pus. In some of the subsequent cases reported this fact is well emphasized.

Figure 9: Mr. V. C. T. was referred to me with a squamous cell carcinoma below the left ear, arising in an x-ray burn. The x-ray treatments had been given for an extensive lupus vulgaris, of forty years duration, and involving most of the left side of the face. He was having considerable pain when first seen in August, 1929.

With a strong high-frequency cutting current the involved area was removed with a wide margin down to the normal underlying fat, a portion of the ear being included. Immediately following the operation the patient was free of pain.

Figure 10: Taken in November, 1929, shows partial healing when he returned for skin graft.

Figure 11: Shows a successful transplantation of a pedicle skin graft from the left shoulder.

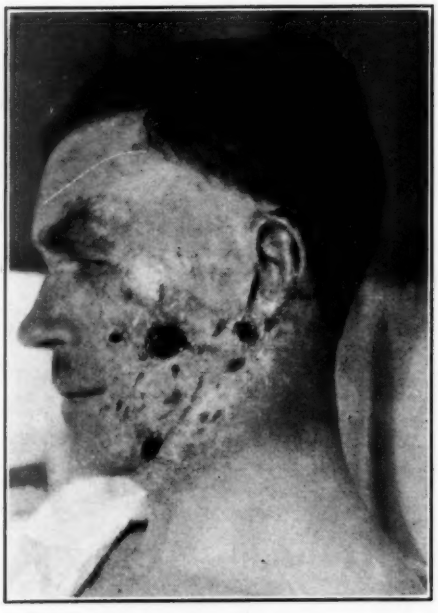
Figure 12: Front view of the same patient. It will be noted that an attempt was made to graft only part of the x-ray scar, it being too extensive for one graft to cover. The patient is to return at a later date for subsequent grafting. At present there has been no recurrence of the disease and he is in good general health. The case illustrates the value of combining plastic surgery with electrosurgical removal of malignant disease in the presence of x-ray burn.

Figure 13: Mr. H. C., March, 1930. I first saw this man in August, 1929, when he complained of an ulcerative lesion 2 cm. in diameter on the inner side of the left jaw, just in front of the angle. I advised radium treatment, to be followed, in a few days, by electrosurgical removal. The two therapeutic agents in such a combination increase the possibility of cure, the period of convalescence markedly diminishing by the elimination of the slowly healing, painful radium slough. I lost sight of the patient until he reappeared in the condition illustrated in Figure 13. During the interval he had received four efficient radium treatments, but the squamous cell tumor being resistant to radiation had continued to grow. Osteomyelitis and bone involvement by growth had given so much pain that the root of the fifth nerve had been severed by operation as a means of relief; the scar is shown in Figure 14. The figure also

Fig. 9

Cancer of left ear following x-ray burn (August, 1929). Patient's original complaint was extensive lupus vulgaris.

Fig. 10



Same patient showing partial healing following use of radical extirpation by strong high frequency cutting current.

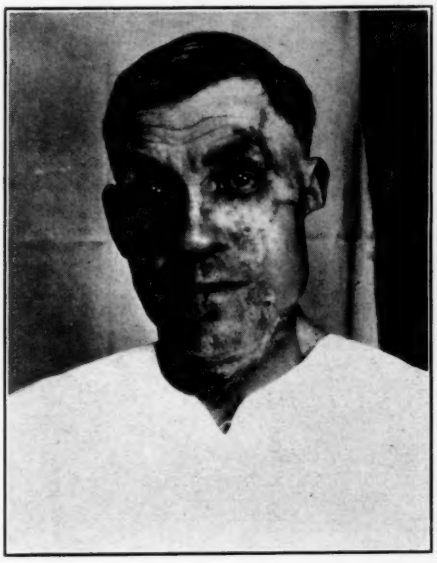
illustrates the marked swelling of the cheek from the tumor involvement.

At the time the patient was admitted to the hospital in March, 1930, x-ray photograph showed destruction of the horizontal ramus of the left mandible with extensive ulceration in the mouth, swelling of the cheek from growth and infection and a huge, cauliflower tumor growing through the skin about 2 cm. thick, just below the angle of the mouth. There was a mass of sub-maxillary glands, but no involvement below the level of the hyoid bone. After admission operation had to be postponed a few days on account of a sudden high rise in temperature—lasting 24 or 36 hours. As the patient was anaemic and cachectic a gastrostomy was performed on March 15, 1930, under local anesthesia. During the next few days, while the wound was healing, he received practically no nourishment and continued to lose weight. On March 19, under local anesthesia, an incision was made in the left side of the neck for ligation of the external carotid artery. It was found, however, that the growth had extended down so far that the ligation of the external carotid was impossible. I therefore ligated the common carotid artery instead. There were no complications following this, and on March 24, under rectal ether anesthesia, I removed the growth using a strong combined coagulating and cutting current. The line of the incision extended back from the angle of the mouth to angle of the jaw, then downward and forward in a curved line to below the level of the hyoid bone and anteriorally to the midline of the neck. Then, to the submental tissues and back to the angle of the mouth, skirting the growth with a wide margin. The chin was resected off the bone, which was coagulated as far as the midline. The entire growth was then dissected free from underlying muscles and bone, and the involved tissues in the floor of the mouth thoroughly destroyed by electrocoagulation. This meant that there would be direct communication between the mouth and the wound in the neck, for which preparation had been made by the gastrostomy. The jaw bone was treated with a heavy coagulating current, destroying all organic matter contained in it, leaving an inorganic bony bridge as a support preventing the jaw from sliding to the left during convalescence. All bleeding points were clamped an thoroughly coagulated. With a strong current the surface of the wound was then sterilized, coagulating to a depth of 1 or 2 mm. During this entire operation only one vessel required ligation, this being the stump of the external carotid artery. In spite

Fig. 11

Same patient; successful transplantation of a pedicle skin graft from left shoulder.

Fig. 12



Front view of same patient.

of the preoperative ligation of the common carotid artery there was some spurting from the external through the anastomosis in the upper part of the internal carotid artery. Indeed, it was not necessary to tie the external carotid to prevent bleeding as coagulation had taken care of this, but a ligature was placed back of the coagulated stump to guard against post-operative hemorrhage.

During the convalescence the patient received feedings through the gastrostomy tube to the amount of 3,200 calories in 24 hours. He not only gained the two pounds he lost before the gastrostomy was used, but six more before his discharge from the hospital on April 12. In spite of the extent of this operation and the large amount of coagulated material left open to the secretions of the mouth, at no time was there any severe infection and the patient was perfectly comfortable and free from pain. I attribute part of the success of this operation to the diligent care of the wound, controlling bacterial infection. All who use electrosurgical methods in the treatment of extensive malignancy should be as careful of surgical asepsis as when handling any other surgical wounds. For this reason those inexperienced and improperly trained in surgery have no business utilizing elecrosurgical instruments.

The gastrostomy served two purposes. First, it maintained the nutrition of the patient; in fact, increased his general well-being over the cachexia caused by the extensive growth and infected slough prior to operation. Secondly, it eliminated the passage of food through the mouth, keeping the wound clean. Daily, the entire wound was painted with H. R. Bohlman's solution of gentian violet (personal communication) the formula being:

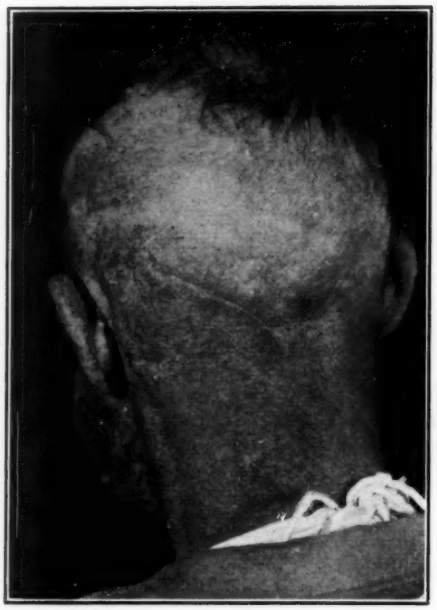
Gentian violet, 2 gms.
Acetone, 10 cc.
Alcohol, 55 cc (95%).
Water, 35 cc.

This solution keeps the wound dry, encourages the penetration of the gentian violet into the depth of the wound and dissolves the fat from around the bacteria allowing it greater penetration. The gentian is markedly inhibitory to the growth of bacteria. During the healing of the wound there was practically no reaction about it and almost no redness of the skin. The control of the infection in this case was so remarkable that I have now adopted the application of Bohlman's gentian solution to all electrosurgical wounds as a

Fig. 13

Malignant tumor of inner side of left jaw (August, 1929), treated with radium and electrocoagulation.

Fig. 14



Same patient showing ineffectiveness of radium in this type of growth. Tumor has increased in size and is now complicated by osteomyelitis and involvement of fifth nerve.

routine measure for the first few days. This is applied before the first dressings are put on at the operating table, and I have yet to see any marked reaction around any electrosurgical wounds so treated, no matter how extensive. Prolonged use of this solution dries out the wound, inhibiting granulations and destroying epithelium. At this stage other antiseptics should be used, for example 2 per cent gentian in 5 per cent glucose (Bohlman).

The patient left the hospital in excellent condition on April 12, and on April 23, under local anesthetic, in my office, I sutured together the left angle of the mouth as illustrated in Figure 15.

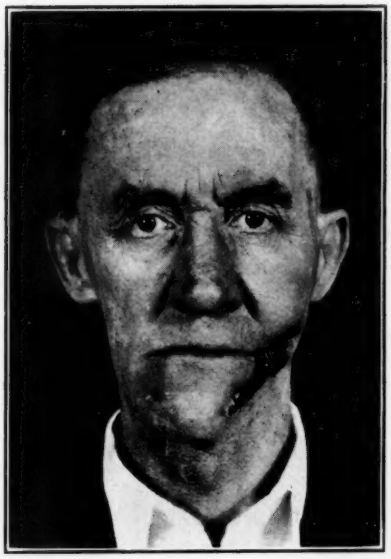
Figure 16: Shows the healing of the wound around the coagulated mandible. The skin of the neck gradually grew over the granulating surface from below the level of the hyoid up to the mucous membranes of the floor of the mouth, beneath the dead jaw. The mandible remained as shown in Figure 16 until about September, 1930, when it cracked and had to be removed. All of the dead bone was rongeured down to healthy bleeding bone tissue, which has since granulated over, leaving practically no raw bone.

Figure 17: Shows the wound as it now appears, March, 1931, one year after operation, awaiting the elapse of a few more months before plastic closure.

Figure 18: Front view, with mouth open. The gastrostomy was used for feeding for six or seven months following the operation; food being gradually taken by mouth so that for the past four or five months he has not used the tube. I am still maintaining the tube in the gastrostomy wound for use in subsequent plastic operations.

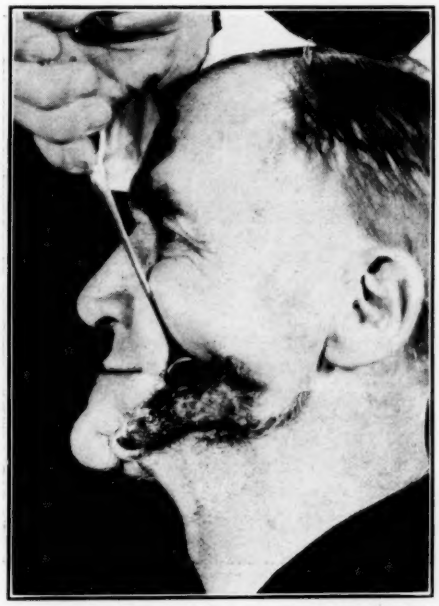
During the description of this case I have mentioned the salient points, which bear repeating for emphasis: First, the importance of early electrosurgical removal of tumors of the mouth following irradiation. Had this been done in this man when he was seen in August, 1929, the chances are that he would have been spared the long painful illness and would have retained his jaw bone. Second, the value of gastrostomy in extensive cancers of the mouth—(a) to maintain nutrition and build the patient's general health; (b) to maintain a clean wound. Third, the need of careful antiseptic and aspetic treatment as a means of hastening convalescence and securing better results should be stressed. Bohlman's gentian-solution has so far been of exceptional aid in keeping down infection. Fourth, within rea-

Fig. 15



Same patient showing line of electrocoagulating incision. A preliminary gastroenterostomy was also performed to obviate feeding.

Fig. 16



Same patient showing clean healing of wound.

sonable limits we can attack extensive cancer cases which appear otherwise hopeless.

Figure 19: Mr. R. W., referred in October, 1927, with an extensive squamous-cell carcinoma (type 1) of the anus. (This case was reported with another in the *International Journal of Medicine and Surgery,* October, 1929, but I use it again to illustrate the treatment of extensive disease with electrosurgery.) Under general anesthetic I operated on this patient, October 11, 1927, using a strong cutting and coagulating current to resect the growth with a wide margin, including part of the external sphincter muscle. I failed to go quite wide enough at the anterior edge of the growth and he was re-operated December 10, 1927. At this point an abcess cavity and recurrence had developed following the first operation, so that there was considerable ulceration from the infection and growth. This required an extensive resection, including part of the base of the scrotum. An uneventful recovery from both operations, however, was made, the patient being in the hospital only six days following the first two days after the second operation, returning to the office for observation and antiseptic treatment.

This case illustrates, first, that electrosurgical operations do not always necessitate long hospitalization, a no small economic saving to many patients. Second, electrosurgical wounds about the anus heal much more rapidly and with better cosmetic result than wounds from irradiation alone. Third, at no time did this patient lose bowel control in spite of the fact that part of the external sphincter muscle was removed. Fourth, because of the soft, pliable scar tissue following electrosurgical operations, subsequent operations, when necessary, can be carried out without difficulty.

Acknowledgment

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Discussion of Papers by Drs. Kelly and Ward

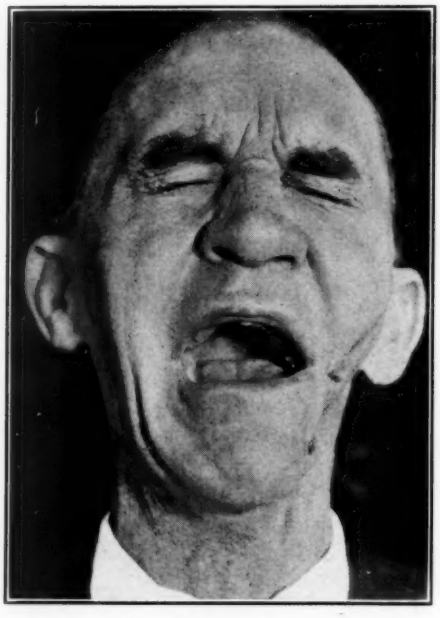
Dr. Edwin Beer (New York): Dr. Kelly has the happy faculty, even if he has not written his paper, of covering an enormous amount of data in an interesting and instructive manner. The photographs that were introduced to illustrate the progress of each patient is an index of scientific labor by Dr. Ward.

There is no doubt that we are on the threshold of a very important era of surgery, whether we call it electro-surgery or not. It involves chiefly the use of the bipolar high frequency current. It might interest this group of physicians to know that the first cutting instrument was made by DeForest and used in the Loomis Laboratory by me in experiments on dogs. DeForest had noticed in his experiments that he had produced a

Fig. 17

Same patient one year after operation awaiting plastic closure.

Fig. 18



Same patient, front view with mouth open.

current that would cut tissue. Then he asked Dr. Weil and Dr. Sternberger to try it out on dogs (1908). It worked perfectly. There was comparatively little bleeding. He was particularly interested in perfecting it from a therapeutic standpoint. However, he never produced a machine which we could use.

Both the monopolar and the bipolar currents have been widely used, but the d'Arsonval circuit alone serves as a cutting current.

Twenty odd years ago, in treating tumors of the bladder, I applied the monopolar and bipolar currents. In the benign growths the treatment was most satisfactory but in malignant growths it usually failed unless they were small. In general, that was my experience with these types of current.

Our own Dr. Wyeth introduced and popularized the cutting current, which marked a great step forward. This has been of particular value in bladder tumor. I do not believe, however, that outside of the treatment of neoplasms that high frequency current offers an enormous advantage.

My experience has been that primary union and healing of the wound is not as readily obtained as in cutting with knife. Kidney operations have been successful with the cutting current but I can see no advantage in cutting the paraties in this way. I believe the future of this whole subject lies in the treatment of tumors. In the treatment of bladder tumors, the tendency to concentrate the heat in the narrow part of the tumor is so effective that by grasping the tumor and using the bipolar current, coagulation of the pedicle takes place in a very short time, so that the tumor can be cut away without any trouble.

Whether the future of electrosurgery is going to be as great as intimated by Cushing in his first paper is still doubtful. I think this is due somewhat to the tendency of the machines to hesitate once in a while in making an incision. When the machines are so perfected that they can be used without any slowing of its cutting speed, without any interruption of current, then we will have made progress in the ideal direction.

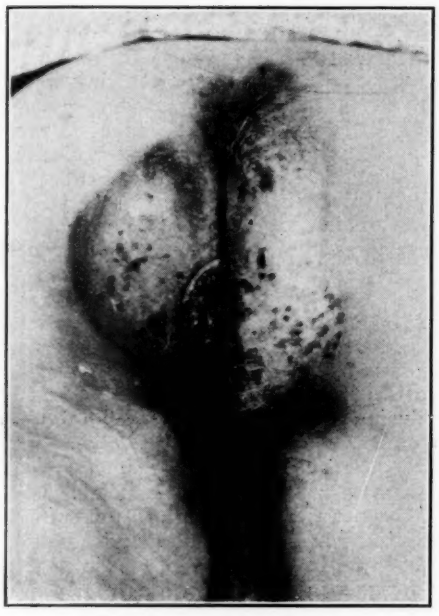
Dr. William P. Healy (New York): It is always a happy experience to have an opportunity to listen to my old teacher, that is to say old in the sense that it is some years since I have had the privilege of sitting at his feet and watch him operate. While Dr. Kelly has always been a great stimulation to me whenever I have had an opportunity of watching him, he has also been almost a source of great discouragement, because he does it all so well and brings with him a perennial wealth of enthusiasm to everything he undertakes. Tonight there is the same situation. He never fails to take the most recent thing and add something to it.

Those of us in New York realize the enormous advance to electrosurgery because of Dr. George Wyeth. Very few of us have had experience similar to his which would permit us to utilize that physical agent in the way he has used it. Still, most of us have endeavored to use it in the small way possible to us, feeling that when a patient has cancer he is entitled to anything which may alleviate pain.

In my work with the pelvic organs in the female we have found the cutting current to be a distinct advantage in conjunction with radiotherapy, particularly with cervical lesions.

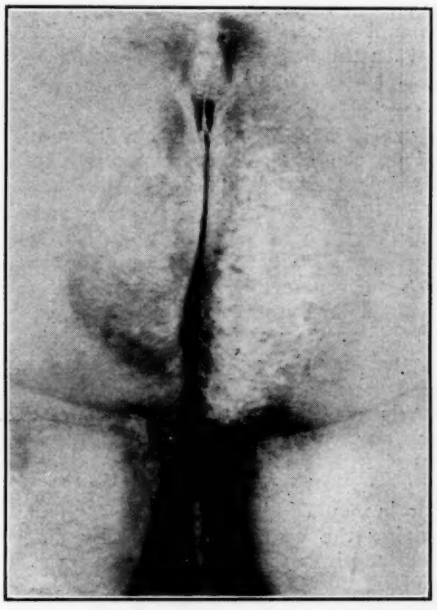
Where the germinal or valve walls were ex-

Fig. 19



Extensive squamous cell carcinoma of anus.

Fig. 20



Same patient, uneventful recovery following electrocoagulation and cutting current.

tensively involved, our plan has been to overdose the tissues with radium, and before sloughing had time to take place to remove, by means of electro-surgery the destroyed scarface area and in that manner provoke better granulation effects. Where we have done that and have had to remove the entire peroneal body, leaving a large hiatus, we have found that by waiting, not being in any hurry to follow up with plastic surgery, but waiting several months and letting the wound adjust itself, as well as to make sure that there is no latent cancer after the electrosurgical procedure, we were able to do better plastic surgery.

We are all much indebted to Dr. Wyeth, Dr. Ward, Dr. Kelly and Dr. Beer for this procedure, and we must all use it. "Some will do better than others in their particular field."

Dr. Howard Lilienthal (New York): I cannot yet speak with authority for I have not had sufficient opportunity to practice this new method. Still, I am an experienced surgeon and I know a little about wounds and how they heal and do not heal, and about accidents and why they happen.

Perhaps some fifty cases, more or less, may seem a small number from which to draw conclusions, but my first three were sufficient for me to decide that I wanted to further my experience with electrosurgery. Dr. Kelly, our venerable friend, need have no regret regarding his inability to perhaps see the development of electrosurgery. He has given this new surgery sufficient impetus to be certain of its progress in the right direction.

I wish that this advance had been brought out many years past. When it was brought to my attention some three years ago I thought it was interesting and good but that it could not be depended upon as for example, cutting with a knife. Then an opportunity was given me to employ a bipolar electric apparatus where a needle was used instead of the blade. The needle rusted quickly and had to be replaced. Finally I threw it away in disgust. Only last spring, however, an instrument was placed at my disposal on condition that I would be willing to report results. I had a representative come to the hospital to demonstrate the instrument and I saw that this really was something worth while. I began using electrosurgery, and with the exception of a few operative procedures where a slow incision was necessary I have used it consistently for skin as well as deeper structures. I am sorry I have not the public hospital facilities where I can work with it in the wards, but if I am willing to use it in my private cases you may realize that I am pretty sure of its efficacy.

I did not prepare a paper for this meeting because I knew there was not much that I could add to what has already been brought out. I do, however, wish to counteract some of the negative impressions left by Dr. Beer. I operate electrosurgically in hernia and have secured beautiful primary union.

Some of us who have tried the method and have not had success in the sound healing of wounds have come to the conclusion that electrosurgery should not be used in the human body. I believe that they have used the knife too slowly so that too deep a layer of tissue has been killed

by the heat. If you have a good cutting electric scalpel it will cut quicker than your hand can move, and you will have a more sterile instrument than the scalpel.

When I suggested using electrosurgery in my first hernia, one of my friends said: "Oh, please don't use it in hernia." But I did use it and in five days the edges of the wound were more solidly united than if I had used the scalpel.

Dr. Lohman of Ft. Wayne was present at an operation and was a little skeptical, but four days afterward when I took out the temporary sutures to separate the skin and remove the packings I had to pull hard to separate the edges. He was convinced.

So much for the rapidity of the healing.

One thing I am going to carry away with me from this meeting and that is the use of the electric current in destroying cancer in the lung. From what I have heard I believe this method will eventually be very valuable in the treatment of carcinoma of the lung, perhaps both by destroying the cancer itself and by destruction of the lymphnodes without removing them by dissection.

I do not wish to leave the impression that I have not had suppuration in any of my cases. I have. I have had it in one case. I shall tell you about it and then close. If you have not had such accidents in similar circumstances but with the scalpel I am willing to believe that it was due to electrosurgery.

The operation has been for cholecystitis, removing the gall bladder. The man was 55 years old. I had to employ a spinal anaesthetic. I had previously operated on the same patient for prostatic hypertrophy. The electric incision was carried through the abdominal wall to the peritoneum. Except for separating a few adhesions, I worked with electrosurgery.

I said at the time: "Here is a case in which the wound may tend to break down. The subject was obese, asthmatic and emphysematous, with a wide and tense costal arch. I left the sutures in for ten days, and on their removal there was separation. Mattress sutures with trouser buttons were then applied. The wound separation had been *after* electrosurgery, but *not because* of electrosurgery. I have seen the same accident happen several times, before electro-surgery became an interesting issue in surgery.

Dr. Beverly Chew Smith (New York): There has recently occurred an enthusiastic, widespread use of electricity in surgery for cutting, dissection and coagulation. As has been the case with new methods, their use has rapidly extended into pioneer fields before their rationale has been entirely proven. This procedure has gone forward with empirical progress. Surgical enthusiasm for the use of electricity has now had the advantage of sufficient observations and Follow-Up's to dispassionately judge of its uses and indications. For the past year at the Presbyterian Hosiptal, we have used a type of machine said to supply a cutting current of 6,000,000 oscillations per second, namely a radio wave apparatus, which, unfortunately, despite its usefulness, has been called a radio knife, thereby giving the lay mind a more fanciful idea of it than deserved.

Our use of this cutting current has been confined to straight surgery, exclusive of gynecology or genito-urinary cases. The first observations were made with wound healing following incision with the electric cutting current. Primary union of wounds obtained in anaesthetized laboratory animals preceded its introduction into the operating rooms. Its use for hernia incisions and other clean abdominal operations has demonstrated that wounds so made heal by primary union. Along with a cutting current we have used a coagulating current for hemostasis. Hemostasis has been accomplished satisfactorily, without the use of catgut or silk ligatures, thereby reducing the amount of foreign bodies for absorption in these wounds. We have noted such wounds to heal cleanly without subcutaneous collections of blood, serum, or exudate. We have come to expect primary union in uncontaminated wounds in spite of the unusual microscopic picture produced by the electrical cutting current in these wounds in various periods of their repair.

In a patient (M. P.) under spinal anesthesia prepared for cholecystectomy, while making a transverse subcostal incision, sections of skin and subcutaneous tissues were incised on one side with the current and on the other side with the scalpel. These were cut to show both sides of the section for comparison and the results are shown herewith.

Slide No. 1—Section showing incision with knife.

Slide No. 2—Opposite side of the same slide showing electro-cautery knife incision, using a slow current of moderate intensity electrode in slow socket, switch on 3, using 9 millivolts of current.

Slide No. 3—Electrode in medium socket, switch on 3.

Slide No. 4—Electrode in fast socket, switch on 3.

Slide No. 5—Blood vessels coagulating by touching hemostat on the vessel for 5 minutes.

Slide No. 6—Coagulating current applied to hemostat on vessels for two seconds. (The coagulating current is really very useful and time-saving.)

In extensive operations such as mastectomies, coagulation hemostasis reduces the operating time approximately twenty to thirty minutes, by doing away with the necessity of many ligatures. This current is used on all the vessels except the large tributaries of the axillary vein. It is used on the perforators. Radical mastectomy has been done using ligatures only on the tributaries of the axillary vein and artery. Wounds have healed without hematoma or sloughing. For radical mastectomies the coagulating current frequently seems of more value than the cutting current. This is because of the type of radical mastectomy operation developed by Dr. Hugh Auchincloss and done under his direction used

on the Second Surgical Division at Presbyterian Hospital. It embodies the principles of wide skin excision of Halsted, and of close, wide skin undermining of Sampson Handly. This undermining is a very important part of the procedure and is done so closely that the skin is left almost as a whole thickness skin graft. To cut this close to the skin with the cutting current is apt to cause sloughing; on the other hand to leave enough subcutaneous tissue to protect the skin from the current is to do an incomplete operation by leaving possible carcinoma bearing tissue. In mastectomies or partial mastectomies for benign lesions, the cutting current is really useful. In axillary dissection of both the vessels and nerve plexus, we feel the scalpel permits a much cleaner dissection without endangering the continuity of the vessels or nerves. We cannot dissect the sheath of the axillary vein, with electrodes we now use, sufficiently close to remove lymphatic bearing tissue, without possibly injuring the vessels. Hence our experience has been in breast cancer that the electric cutting current does not completely supplant the scalpel, nor does the coagulating current completely supplant the use of ligatures, but both currents have a definite field of usefulness, which no doubt, refinements will subsequently enlarge. At present the clinical and anatomical indications for electric currents in our hands are best typified in the following situations:

1. Incision and partial excision of solid viscera.
2. In operations upon the face, tongue, pharynx and buccal mucous membranes.
3. Incisions into exceedingly vascular areas either on the surface or in cavities.
4. Pulmonary incisions and excisions. Both currents are useful for excision of thickened pleura. Coagulation followed by the cutting current is almost bloodless.
5. Excision and hemostasis in thyroidectomy.
6. For hemostasis in large wounds where quite a number of ligatures are required, radical mastectomies for example.
7. In operations upon patients with blood dyscrascias, such as purpuras, and hemophlicias, and also where oozing is a problem, as in long, deeply jaundiced cases.
8. In the few instances where we have used both currents on the cervix, they have been satisfactory.
9. Its use in brain surgery has been definitely established.
10. The Oudin desiccating current has satisfactorily entrenched itself in dermatology.

On the contrary, there exists clinical and anatomical situations in which the use of electric currents for cutting and coagulation are rather contra-indicated, such as lymph adenectomies in cervical, axillary, femoral, or inguinal regions, where dissection must be done in the proximity of large vessels and nerves.

Second, in operation upon skeleton muscles, the current causes contractures.

Third, if close skin undermining is done in mastectomies, it is questionable that the cutting current should be used because of danger to the skin and subsequent sloughing.

Fourth, incisions into areas of diminished blood supply, such as in vascular diseases of the extremities, the chances of sloughing seems greater than in scalpel made wounds.

Time, experience and manufacturing refinements will no doubt increase the indications for electrical currents in surgical treatments, but at this time it may be well to take stock and appraise their present usefulness, rather than too enthusiastically to attempt applying these currents to all surgical lesions before Follow-Up results are further noted. Has enthusiasm for the idea of electric cutting currents sealing off lymphatics become so firmly implanted that it has caused a method of excision to displace the established fundamental principle of cancer surgery? We must not cloud the facts with this enthusiasm for one method, but remember to cure cancer, we must primarily excise all tissue pathologically involved.

Dr. A. Bern Hirsch (New York): I want to make a brief historical correction as to the beginnings of surgical diathermy. Professor d'Arsonval of Paris in his laboratory of the College de France performed a number of experiments that led up to discovery of medical diathermy. Dr. Joseph Rivière, also in Paris, still active in practice there, saw the work d'Arsonval was doing with autoconduction and, in experimenting with a duplicate apparatus, accidentally received a spark on his hand while giving a treatment. He applied such sparking the next day to an ulcer on the back of the hand of a patient who had been unable to effect a cure for years. By such sparking he soon cleaned up this condition. There was the beginning of surgical diathermy.

Dr. de Keating Hart in 1911 came to America to demonstrate what he claimed was his original method of surgical diathermy. He said that Doyen had first instructed him; as a matter of fact, Doyen first came to Rivière to learn. When Dr. de Keating Hart repeated his claim to originality at the Budapest International Congress he was taken to task by Doyen for claiming priority and was told it was Joseph Rivière who had been the actual discoverer.

Dr. John A. Wyeth (New York): When in January, 1924, I published in the Annals of Surgery an early report of my work with endothermy, Dr. Kelly was one of the first men to come to my office to inquire about the new method. He brought three patients for operation and four assistants to learn the exact technique. When we realize that for thirty years he had wielded the scalpel at Johns Hopkins and that he owned perhaps a half million dollars worth of radium (having been with Dr. Robert Abbe the owner of the first radium in this country) we must see that he showed on that occasion a breadth of vision that marked him as a truly great man.

I want to say just a word about my early experience with the cutting current. Through the

kindness of Dr. James Ewing I was able to secure a place in the old Loomis Laboratory, opposite Bellevue Hospital, down on East 26th Street. There we started work with an old, large, cumbersome radiotherm, in conjunction with the research department of the Wappler Electric Company. I want to tell Dr. Beer that I am not the first man that ever thought of the cutting current. Back in 1904 a man by the name of Cohen tried, with Dr. De Forest, to do an operation with a damped cutting current at the Moabit Hospital, Berlin. The machine did not stand up, however, and the idea was discarded. Our work at the Loomis Laboratory resulted in the discovery of the fact that one tube of the De Forest modification of the old Fleming tube would rectify with another. It was only then that we were able to secure a constant undamped current that would stand up. It was then that the first *perfected* cutting current was produced. This, of course, did away with the old, temperamental, unreliable, bulky rectifier which had previously been tried. I reported this work before the Surgical Section at Rochester in April, 1924, and was fortunate in having Dr. Kelly at that time discuss the paper.

The principal advantages of endothermy are the sterilizing of tissues, the sealing of lymphatics and the elimination of trauma. Electrosurgery can be combined with other methods of treatment; it can be used with radium if necessary although I feel that if a thorough electrosurgical job is done radium is not necessary except, of course, as an extra precaution.

One of the happiest offshoots of this perfected cutting current has been the handy cutting current biopsy electrode. It is today a simple matter to thrust this electrode into the tissue and take out, with the greatest ease, least trauma and utmost safety, a cube-shaped piece for frozen section which latter can now be carried out as an office procedure. Intelligent interpretation of the frozen section enables us to determine the three fundamental things which everyone who treats cancer should know before he starts treatment; namely, what kind of a cancer is it? What is the degree of malignancy? Is it radiosensitive or radioresistant? With this knowledge in hand we have something definite from which scientifically to treat our case. If it is a radiosensitive tumor thorough radiation is immediately instituted; if it proves to be radioresistant we attack immediately by endothermy which offers all of the scalpel's advantages and the added protection of sterilized tissues and sealed lymphatics and consequent minimizing of the likelihood of metastasis or recurrence.

I do not want to add anything to what has been said about primary healing but I might mention that primary healing is merely a matter of adjustment of your current. If the current is properly adjusted for the minimum of destruction we get primary healing; if the adjustment is such that necrosis is produced we will not get primary healing.

There should be no post-operative bleeding. Its prevention is assured by the use of surgical judgment. If one expects bleeding he should provide against it by previous ligation, just as in any other surgical procedure.

EFFECTS OF SUPER-HIGH-FREQUENCY RADIO CURRENT ON HEALTH OF MEN EXPOSED UNDER SERVICE CONDITIONS *

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In accordance with the request of Naval Operations, an investigation of the effects and possible hazards of exposure to super-high-frequency radio currents was taken up by the Bureau of Medicine and Surgery in July, 1930. The basis of the request was the occurrence of certain subjective symptoms among exposed employees at the Naval Research Laboratory, Bellevue, D. C., in testing the powerful radio machines fabricated there.

A number of individuals and institutions outside of the Government have been interested to follow up the reactions to super-high-frequency induced currents which have been observed in man. They have been alert, of course, for any untoward effects, but the primary object of their investigations, with a few exceptions, has been to determine the therapeutic value of the agency. While duly interested in possibilities in this direction, the requirement assumed for the moment by the Medical Department of the Navy was the determination of any danger to the engineering research and development force at the Naval Research Laboratory and, by inference, to exposed operators of powerful machines installed on ships of the Navy.

The investigation was directed to this side of the problem and resolved itself into the following questions concerning possible effects resulting from multiple moderate or extreme exposures:

(a) As an extension of the known immediate reactions, is there any cumulative disturbing change in normal physiologic function?

(b) Is any catabolic chemical change stimulated?

(c) Is any acute or chronic degenerative biologic process initiated?

(d) Can observed results, if any, of animal experimentation be translated into terms of the consequences of probable human exposure?

(e) Can adequate safeguards be erected against such exposure if shown to be attended by hazards?

The conclusions are the result of carefully conducted observations of engineering, research, and development personnel under exposure at the Naval Research Laboratory, of a study of the accumulated literature on the subject, of consultation with various scientists (direct and by correspondence) relative to recent unpublished work and opinion, and of animal experimentation. The employment of animals was desirable and, indeed, important to reasonable conclusion, and this was the time-consuming part of the investigation.

The machines now tested at the Bellevue Laboratory in radio communication research develop power up to 20 kilowatts and 80,000,000 cycles per second. The personnel is normally exposed in this work to an electro-static and inductive field which is unmeasurable with any accuracy.

In this connection, Dr. W. R. Whitney, of the General Electric Co., says of their investigation at Schenectady, N. Y.: "With those fields which were not intentionally arranged to give maximum heating effect there was only something like 1 degree rise in body temperature observable. It was only when we intentionally made the apparatus in a form containing two large condenser plates that we raised the temperature of human beings and of animals by placing them between the plates." With the use of one antenna, which in effect is that which obtains under working conditions at the Naval Research Laboratory, the resultant is not a condenser field in the ordinary sense, and even in a resonance cir-

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cuit provided by two condenser plates the inductive part of the circuit has such capacitance that an ammeter will not indicate accurately "the actual amount of current flowing in different parts of the inductance." However, for the purpose of tests at the Naval Research Laboratory the aim was to reduce variability in focus and intensity of field while in other respects to simulate the extreme limit of normal conditions, but it was impossible with human subjects(volunteer laboratory personnel) to employ the utmost intensity or prolong the period under repeated exposures to the desired extent. By exposing animals in a definite field under accurately controlled conditions of current strength, wave length, frequency and seance-time factors over prolonged periods of repeated interval exposures, such immediate or cumulative and remote pathological effects as might result would be available for definite reading.

The Carnegia Institute of Washington, D. C. (department of terrestrial magnetism) expressed its readiness to cooperate in the animal part of the investigation, and through its representation by Drs. M. A. Tuve and W. G. Whitman, who were interested in the subject and equipped for the purpose, contributed splendid assistance. By this means the limitation in the resources of the Naval Research Laboratory and the Naval Medical School laboratories were completely and satisfactorily compensated.

The symptoms occurring in the personnel as a result of exposures normal to an ordinary day's work in the electrical field induced by the operation of the powerful radio machines at the Naval Research Laboratory and elsewhere are reported as headache, fever, lowered blood pressure, dizziness, drowsiness, and fatigue, all of slight though varying degree. The physiological effects of currents of lower frequency, such as diathermy, are well known. Essentially these alternating currents produce only moderate temperature elevations, due to the electrical resistance of the body, confining themselves in their action, according to Loomis and Christie[5], "almost solely to the extracellular fluids," whereas high frequency "currents actually penetrate the living cell by reason of the thinness of the dielectric layer surrounding the cell, which transmits the current by means of its capacitance. The heat produced at these frequencies can be wholly accounted for on the basis of ohmic resistance and dielectric loss."

The physiological effects of super-high-frequency currents have not as yet been thoroughly investigated, but much has been done and is in progress. Schereschewsky[1] reports the destruction of tumors of experimental mouse sarcoma. Carpenter and Boak[2] report the cure of 21 rabbits that were intratesticularly inoculated with syphilis by repeated exposures in which the body temperature was raised to 103°—106° F. They also noted that the animals seemed to become more tolerant to exposures as suggested by delayed reaction in successive treatments. Schaible and Knudsen[3] have studied the blood chemistry of dogs exposed to super-high-frequency currents and conclude that the only effects are those due to hyperpyrexia.

Schereschewsky[4], Christie and Loomis[5], and Carpenter and Page[6] concur in this view. On the other hand, Tuve and Whitman[7], using extremely high-power exposures, giving a rate of 1° C. per minute in general temperature rise, have produced a complete soft tissue destruction in the hind limbs of cats. Their preliminary findings indicate that this result was not in the nature of a burn, for there were no characteristic surface manifestations of such action and the destructive process did not show itself until three or four days after the exposure. They believe, however, that it is probably a somewhat delayed expression of an actual heat effect concomitant with exposure involving the trophic control of the parts concerned, in the neurons of which there may be either a production or accumulation of greater heat relative to other tissues as a consequence of differences in response to thermic regulation or a greater susceptibility to heat effects. They think it possible also that the actual rate of rise of temperature is an important factor. In his various experiments, Schereschewsky[1], [4] also observed tissue destruction of a necrotic character ranging from superficial skin reactions with alopecia and the formation of a small eschar, which, coming away, left an area of healthy skin, to deeper and permanently destructive sequelae such as the loss of anatomical parts (ear and tail) in a process of necrosis or dry gangrene preceded by flushing, cyanosis, and hemorrhagic (ecchymotic) areas along the course of the blood vessels. Mellon et al.[8] have reduced

the potency of diphtheria antitoxin to a twenty-fifth and have proved that this change is not a temperature effect.

The super-high-frequency transmitters used by all of the above investigators, except Whitman and Tuve, have been of 500-watt power and frequencies from 155,000,000 to 60,000,000 cycles per second.

The Physiological Effects of High Temperatures

The excellent monograph of E. E. Smith[9] on heat stroke contains the following summaries:

1. Optimum atmospheric working conditions are: Temperature 68° F., relative humidity 50 per cent, 45 cubic feet of air per person per minute.

2. The body heat is lost by conduction, by convection, and by radiation.

Conduction increases with humidity.

Convection increases proportionately to the square root of wind velocity.

Radiation is proportionate to the difference between the temperature of the body and that of the surrounding air.

3. Chilling produces an anhydremia with loss of fluid from the blood to the tissues. Heating produces hydremia with absorption of fluid from the tissues.

4. Hot baths (110° for 15-30 minutes) cause a pulse rate of 160, a mouth temperature of 102-104°, a systolic blood pressure of 60 mm. hg., and a fall in alveolar CO_2 tension with corresponding rise in O_2 tension, permitting subject to hold his breath two and one-half times longer than normal.

5. With wet bulb at 96° F. (35° C.) in a ventilated space the reactions are (1) sense of warmth, (2) at onset of perspiration a general relaxation and sense of drowsiness, (3) with rectal temperature of 99.5° F. a definite change to wakefulness, with irritability and restlessness. At 103° F. the irritation is exaggerated. At 106° to 108° coma, delirium, and convulsions occur.

6. Dark skins absorb more heat than light skins and they respond more promptly with perspiration and a resulting fall in skin temperature.

7. In heat exhaustion in dogs the following occur: (a) Fall in alkali reserve, (b) decrease in pH of blood, (c) blood lactic acid increases 300 per cent, (d) moderate elevation of nitrogenous elements, ascribed to increased production rather than to retention.

8. In temperatures just above normal, changes in nerve cells have been observed and the lipoids lose their anisotropy. In body temperatures above 107° F. (42° C.) changes occur in Nissl's granules, and if the temperature is maintained coagulation of the nerve cell occurs. Structural changes occur in the anterior horn cells which are ascribed to physico-chemical disturbances because these lesions can not be reproduced post-mortem by temperatures of 112° F.

9. Muscle cramps, including deaths of cardiac origin, are ascribed to localized tetany with accompanying derangement of the calcium metabolism.

The Super-High Frequency Radio Transmitter

The electrical field surrounding the super-high frequency transmitter at the Naval Research Laboratory produces some interesting effects. It is possible, for example, to illuminate the filament of an ordinary incandescent bulb held in one's hand at a distance of some 20 feet from the machine, the necessary electrical energy being absorbed by the body, which acts as an antenna. This absorbed electrical energy is first felt in the extremities, and a stay of several minutes in the vicinity of the machine is followed by unpleasant warmth and sweating of the feet and legs. Continuing in the electrical field general body warmth and sweating, drowsiness, headache, pains about the ankles, wrists, and elbows, weakness, and vertigo occur in the order named.

The men at the Naval Research Laboratory who volunteered to submit to super-high frequency exposure under medical observation, were asked to take as much exposure as they felt that they could with safety. The standard procedure adopted for conducting the observation on the volunteer was as follows: The man undergoing examination stood about 4 feet from the machine in an area where the maximum electrical effects were felt. Although standing, he was kept in a state of rest as far as consistent with the posture in order that the effect of the exposure *per se* might not be falsified by the influence of physical activity. As symptoms apparently did not develop as rapidly when the subject stood at comparative rest in the electrical

fields as when he was working, the technical staff devised an antenna to augment the electrical effects. The antenna was a metal rod about 40 inches long and 1 inch in diameter and was held in one hand by the subject. This rested on a steel fence, which absorbed and transmitted additional current. For convenience in this report the hand holding the antenna is referred to as the antenna hand.

An ordinary clinical thermometer was kept under the tongue and frequent readings made.

The skin temperatures were recorded with spirit thermometers.

A single exposure producing fever and one or more other symptoms was given to three of the volunteers; one volunteer had three daily exposures and two had five daily exposures. The repeated exposures were made on consecutive days.

Investigation of Effects

Investigation of any possible deleterious effects involved the consideration of (a) a complete physical examination of the personnel who were to be or had been exposed to these fields in order to determine their norm for comparison with findings under (b) and (c); (b) observation (clinical and laboratory) of volunteers during exposure; (c) post exposure examination; (d) observation, including post-mortem findings, of animals exposed to these electrical fields.

(*a*) *Preliminary examination of human subjects* (*volunteers*).—This embraced a medical history, an electrical exposure history, and a complete physical examination, including blood count and urinalysis. The findings were noted as establishing the base line for each individual and for later reference. No abnormal findings which could be ascribed to the effects of super-high frequency currents were revealed.

An inquiry into the illnesses of three men employed in the high frequency work revealed the following histories:

1. R. C. S., had an arrested case of pulmonary tuberculosis when he entered the employ of the Research Laboratory. The tuberculosis subsequently became active and he is now undergoing domiciliary treatment.

2. J. D. W., a resident of Louisiana, had a malarial condition for two years before entering the employ of the Naval Research Laboratory. The malaria was resistant to ambulant treatment and he is now undergoing hospital treatment for the malarial infestation.

3. J. T. F., an assistant radio engineer, was pursuing advanced academic work at a local university in addition to his regular duties at the Naval Research Laboratory. His friends report that he was overworking, obtaining insufficient sleep, and no outdoor exercise. He developed active tuberculosis.

None of these illnesses can possibly be ascribed to electrical effects and none of these three men were used in these tests.

The six volunteers were radio engineers and physicists attached to the research laboratory. Four had had exposure to super-high-frequency for the past year. Two had practically no previous super-high frequency exposure and served as controls.

All those who had been definitely exposed and had experienced symptoms were unanimous in stating that repeated daily exposures cause headache, weakness, and drowsiness, and that the weakness and the lethargy occur earlier in succeeding exposures, become more intense, and last longer after the exposure ceases. All reported also that they were always entirely normal following a day or two without exposure to the super-high frequency fields. The complaints are limited to those working with currents of 10 to 20 kilowatt power. There has been no subjective distress among the personnel working with ½ to 2 kilowatts and frequencies up to 75,000,000 cycles.

The maximum exposure occurred in an assistant radio engineer (D), who estimates that he has had an average daily exposure of 20 minutes for the past year to a current of 5 to 20 kilowatts at frequencies of 4,000,000 to 55,000,000 cycles per second.

(*b*) *and* (*c*) *Observation of volunteers exposed to the super-high frequency fields.* This observation embraced —

(1) Wet and dry bulb thermometer and barometer readings.

(2) Air flow.

(3) Body temperature, pulse rate, blood pressure, and respiratory rate during and at intervals after exposure.

(4) Urinalysis, complete blood count, blood-urea nitrogen, creatine, CO_2 combining power, blood sugar, blood chlorides, blood phosphorus, blood calcium, and coagulation

times, taken immediately after exposure for comparison with the before-exposure record.

(5) Skin temperatures.

(6) Symptoms and time of appearance.

1. Atmospheric conditions varied from dry bulb and wet bulb maximum readings of 27 and 19° to minimum readings of 21:5 and 15° C., respectively. The exposed personnel were relatively more comfortable on cooler, less humid days, but except for delayed development the symptoms did not appear to be modified.

Barometric readings varied from 29.60 to 30.08.

The relative comfort of exposed personnel on cooler days must be ascribed to the atmospheric conditions favoring heat lost by the body, since the change of electrical constants of the atmosphere would be entirely negligible in altering the degree of electrical exposure.

2. Slight draughts were always present, though the rate of air flow was insufficient to be recorded by an anemometer.

3. The mouth temperature of the person exposed regularly rose several tenths of a degree, the maximum elevation being from 98.8 to 100.

There was a tendency for the pulse rate to become accelerated during exposure. The maximum change was a pulse rate of 80 becoming 114.

The blood-pressure changes were so slight that they were well within the limits of normal variation. There was, however, a distinct tendency for both systolic and diastolic levels to be slightly lower one-half hour after the exposure.

The respiratory rate was unaffected.

4. The results of the laboratory examinations are combined in Table I. The only consistent finding is a slight drop in the CO_2, combining power of the blood plasma, and a slight though fairly regular deviation of the urinary pH to the acid side.

5. *Surface temperatures.*—A rather remarkable change in the skin temperature was recorded by the very crude method of placing spirit thermometers on the wrists of the two hands. The hand holding the antenna gave readings from 2° to 5° C. higher than the other hand. This skin temperature elevation occurred before any rise in the mouth temperature.

6. *The occurrence of subjective symptoms.*—These progress in a fairly regular order. They are presented, together with other observations not included in the table "Summary of laboratory data," in Table II, which is in three sections.

The first symptom of warmth in the antenna hand occurred immediately. After three to five minutes the discomfort became so intense that it would be necessary to shift the antenna to the other hand. The sensation of warmth would be next felt in the feet and ankles, then the body generally, then about the head.

The second symptom usually was a cramp-like pain felt in the bones or tendons of the wrist of the antenna hand. This usually appeared in about three minutes. It rapidly attained excruciating proportions. It disappeared immediately on releasing the antenna. Local muscular weakness accompanied the pain. The pain could not be localized. It was not a joint pain. There was no evidence of tetany or spasm of the muscles of the forearm. In some the pain seemed superficial, being increased by pressure. In others, all degrees of external pressure had no effect on the pain. A pain of the same character would sometimes be felt in the ankles.

The third symptom was sweating. It followed the same course as the sensation of warmth. In only one of the six exposed was the sweating described as exhaustive.

The fourth symptom was either weakness, drowsiness, or headache. Nothing characteristic was elicited about these symptoms. The weakness was general; it was that of fatigue rather than exhaustion. The drowsiness was of the normal type. The headache varied in location, in character, in intensity, in duration, and it was unassociated with blood pressure, pulse rate, or degree of temperature elevation.

In the three volunteers who had repeated exposures a loss of weight occurred. One (O. C. D.) having five exposures lost 2½ pounds during the week of exposure. This was regained in two weeks. His headache had become constant during the last two days of the exposure and this headache persisted for three days following exposure. He reported a noticeable lack of energy and endurance. The recovery from this was gradual but progressive during three weeks. An intercurrent respiratory infection may have been a factor in his prolonged symptomatology.

Another (R. A. G.) having three exposures

had lost 2 pounds the week before exposure and lost 6 pounds during the week of exposure. This weight loss, remained stationary for the few days at the end of the exposure week, was regained during the following two weeks. A noticeable lack of energy and endurance occurred which gradually disappeared in three weeks.

In connection with the loss of weight and other symptoms in this case, it is to be noted, as very probably contributory, that this man had been making a difficult radio installation in a submarine before exposures, and that he continued this work during and after the period of the test.

The third volunteer (L. C. Y.) lost 5 pounds during the week of exposure and regained it in two weeks. He had no subjective symptoms following the exposures.

It seemed that the taller men among the volunteers, and those of a blond complexion suffered more electrical effects than shorter, darker men.

L. C. Y. was the shortest man in the group and is a pronounced brunette.

O. C. D., who developed the greatest effects, is a 6-footer with light brown hair.

R. A. G., whose symptomatology was intermediate, is a 6-footer but a pronounced brunette.

(*d*) *Animal experiments.*—For purposes of observation the animals were divided into three groups:

1. On the 22d, 23d, and 25th of August, at the Naval Research Laboratory (18 kw., 55 m. cycles, 5.45 meters, 15-inch air gap and 45-minute exposure), and subsequently at the Carnegie Institution (3½ kw., 61 m. cycles, 4.92 meters, 5¾-inch air gap, and 30-minute exposure), beginning August 28,* for an additional period of six successive days, six guinea pigs were subjected to a sufficient exposure to induce temperatures of 106° to 109° F. The hyperthermia induced varied in the different pigs. After exposure on September 1 (seventh day) all appeared in normal condition except the white (temperature 108.2° F.) and brown (temperature 106.4° F.) pigs, which were, respectively, "just able to crawl" and "quite weak." After exposure on September 3 (ninth day) the white pig, whose temperature had reached 110° F., died (a thermic death) and was autopsied.** Thereafter reduced exposure time was used for 28 additional exposures, making a total of 35 exposures. The standard exposure adopted was 15 minutes, with other conditions as above. The condenser plates were covered with plate glass to prevent arc burns. With a power of 3½ kilowatts to oscillator and a frequency of 61 m. cycles and with the pigs in position, an electroscope indicated approximately 300 volts R. M. S. (root mean square) radio frequency. Since unrectified alternating current was used on the plate of the oscillator, the radio-frequency peak voltage would be considerably higher than this figure, but certainly could not exceed, for example, 2,500 volts. The brown pig died September 29 and was autopsied.*** The remaining pigs were given sufficient exposures six days per week to cause a temperature of 104° F. The average weight of the six pigs were 698 grams. The weight of the white pig was 664 grams and of the brown 686 grams. Two of the surviving pigs were killed and autopsied; the other two are still alive and apparently normal (January 21, 1931).

2. The second group of six pigs, average 406.33 grams in weight, was subjected to the test on six days of each succeeding week for a total of 27 exposures. All of these exposures were sufficient to induce a temperature of 104° to 106° F., the time factor (8 minutes) being the only variant in the conditions obtaining as compared with those to which the first group was exposed at the Carnegie Institution. Four of this group survived the exposures, two having died of intercurrent disease (pneumonia) and two of the survivors were killed and autopsied. The remaining two are still alive and apparently normal (January 21, 1931).

3. The third group of animals consisted of four cats, each of which was subjected, under conditions parallel to those obtaining with the animals of the other groups. The exception, as required by the larger size of the cats, was that the air gap was increased to 7 inches. Owing to this fact the radio-frequency voltage between the plates was undoubtedly somewhat different. There was a sufficient exposure to cause temperatures of 102° to 104° F. Exposures began September 22 and 6-day-per-week seances were continued. Two of them died of intercurrent dis-

* On August 26 the machine at the Naval Research Laboratory broke down and the pigs were transferred to the Carnegie Institution.

** Intercurrent infection (inflammatory pleurisy).

*** Pneumonia.

ease (pneumonia). The two that survived were given a total of 12 exposures. One of these was killed and autopsied; the other one is still alive and apparently normal (January 21, 1931).

The animals were exposed in a dry wooden box with air holes. They were frequently weighed and examined daily for ill effects. Two of the surviving pigs in the first group were rendered comatose and had convulsive seizures. None of the animals lost weight. Except for the electrical exposures and confinement, the living conditions of the experimental animals were normal in every way. The intercurrent disease, causing death in some of the animals, is believed due to the chilling contrast of the existing atmospheric conditions immediately after the induced internal temperature.

A fourth and supplementary group of some 20 reserve pigs was subject at irregular intervals to short and intense exposures. About 50 per cent of these showed local superficial transient disturbances with resulting alopecia and eschar. The snout of one pig was thus affected and, curiously and inexplicably, the outer left carpal area of the other affected pigs of this group.

No direct evidence was obtained as to the relative resistance or susceptibility of the experimental animals nor was any variation in basic resistance noted under conditions of exposure in the tests. It may be noted that the pig which died a thermic death was an albino, but this fact can not be taken too seriously, for its resistance had been lowered by some intercurrent infection and the temperature which it developed would probably have killed any of the other pigs. Under the circumstances, the question of the protection offered by pigment in the lower tolerable temperatures induced in the other animals under parallel exposures is purely academic. All the living animals will be kept under observation to determine if any late effects occur. If so, they will be autopsied and the organs and lesions studied as the basis for a further report.

Prof. Arthur Knudsen, of Albany Medical College, advises us that, in experiments subsequent to a preliminary report to the International Physiological Congress[3] he and Philip J. Schaible induced a temperature of 106° F. in rats every day for a period of two to four months without any cumulative effect. And Dr. R. V. Christie, writing to us personally, says, "Of course, if the heat production leads to systemic elevation of temperature, changes in the blood pressure, blood chemistry, etc., can be observed, but there is absolutely no evidence to show that any of these changes have a deleterious effect" short of the direct lethal results of extreme hyperpyrexia.

In personal communications, Dr. W. R. Whitney, of the General Electric Co., who has had prolonged opportunity to observe the effects of super-high frequency radio, advises that nothing harmful has resulted from radio fever below 105° F., and that although "probably dangerous to run much higher temperature" experiments with animals (dogs, rabbits, mice, etc.) indicate the lethal temperature to be above 108° F. He says the first dog received by him for experimental exposure over a year ago was a sickly animal, but is alive and well now after 10 or more exposures for 40-minute periods developing a temperature as high as 105.5° F.; that Doctor Knudsen, of Albany Medical College, thinks a dog may be heated as high as 110° F. for a moment, though prolonged heating at that temperature is fatal; and that Doctor Walker, of Baltimore, has found mice to stand a temperature as high as 112° F.

In the exposure of animals at the Naval Research Laboratory, two metal plates were substituted for the radio aerial, and the experimental animals were placed in an insulated perforated wooden box between the plates. A current of 15 to 18 kilowatts, with a frequency of 55,000,000 cycles per second, was used. The air gap between the plates was 12 inches.

At the Carnegie Institution Laboratory, to which the animal work had to be transferred, a machine of the same capacity was used, but the power was reduced to 3½ kilowatts in order to give the desired rate of temperature rise with an air gap of 5¾ inches. The frequency was 61,000,000 cycles per second. Here also the animals' exposure to the field was in an insulated perforated wooden box.

Post-Mortem Examination of Animals

The gross and histological post-mortem examination of the tissues of these animals showed only thermic changes. All the organs and tissues that could be of any possible interest from the point of view of this study

TABLE I.—*Summary of laboratory data—The difference between findings (changes occurring) in the examinations before and after exposure*

[+ Increased; − Decreased; × unchanged]

Case	Y	Y	Y	Y	DR	DR	DR	DR	DR	G	G	M	W	DA	Total + and −
Red blood count.....number..	−40,000	−200,000	−80,000	−140,000	−140,000		+10,000	+40,000	+70,000	+20,000	−160,000	−130,000	−60,000	+160,000	+5 −8
White blood count.....do....	+500	+1,900	−900	+2,500	+2,500		−500	−300	+200	+1,500	+1,300	−1,400	−600	−1,200	+7 −6
Polys.....per cent..	+13	+3	×	+6	+6		+3	−9	+4	−4	−5	−3	+5	+3	+8 −4 ×1
Band forms.....do....	+4	×	×							−1	−2	+1	+1	×	+3 −2 ×3
Segmented.....do....	+9	+2	×	+6	+6		+3	−9	+4	−3	−3	−4	+4	+3	+8 −4 ×1
Lymphocytes.....do....	−6	−3	−1	−8	−8		−7	+11	−2	+3	+5	+4	−5	×	+4 −8 ×1
Eosinophiles.....do....	−3	×	×	+3	+3		×	−1	−1	+2	−1	+1	−1	−1	+4 −6 ×3
Basophiles.....do....	0	0	0	−1	−1		−1		×						+0 −3 ×1
Monocytes.....do....	−4	×	×	×	×		+4	−1	−1	−1	+1	−2	+1	−2	+3 −6 ×4
Hemoglobin.....do....	×	×	×	−5	−5		+5	×	×	×	×	×	×	+5	+2 −2 ×9
Coagulation time, minutes: seconds	×	−0:5	×	+0:4	+0:45		+0:10	+0:55	+1:15	−0:10	+0:50	−0:50	×	+0:50	+7 −3 ×3
Blood urea nit. milligrams per 100 cubic centimeters	×			+1.0	×				×	−3.0	−1.0	×	×	−2.0	+1 −3 ×5
Creatinin, milligrams per 100 cubic centimeters	×			−.1	+.2				−.2	×	+.2	+.1	×	+.1	+4 −2 ×3
Blood milligrams per 100 cubic centimeters:															
Sugar	+9			×	−21				×	×	×	+6	−10	+4	+3 −2 ×4
Calcium	+0.3			×	+1.3				×	−.2	−.2	+.1	+0.2	−.1	+4 −3 ×2
Phosphorous				×					×	+.2	+.1	+.1	+0.1	−.7	+4 −1 ×2
Chlorides	×			×	+38				×	×	−20	×	×	−40	+1 −2 ×6
Blood indican quantitative				×					×	×	×	×	×	×	+0 −0 ×7
CO_2 combining power volume per cent..	−3.7			−2.2	−8.5				−4.2	−2.2	+.2	−2.4	×	−1.2	+1 −7 ×1
Urine:															+4
Specific gravity	−.005	×				+.001	×		−.004	+.004	+.006			+.002	−2 ×2
Albumin	×	×	×	×	×	×	×	×	×	×	×	×			+0 −0 ×12
Sugar	×	×	×	×	×	×	×	×	×	×	×	×			+0 −0 ×12
pH	−.4	−1.0	+.3	−.7	×	−1.5	+1.2	−.4	+1.0	−1.0	+.2	+.3		×	+5 −6 ×2
Microscopical	+2BC	×		×	×	×	×	×	×	×	×	×		×	+1 −0 ×11
Amount current:															
Kilowatts	10	18	18	17	18	18	18	18.5	17	18	17	18	18	18	
Megalocytes	55	55	55	55	55	55	55	55	55	55	55	55	55	55	
Minutes	45	19	22	30	35	30	19	22	30	35	32	35	34	40	
Distance.....feet....	4	4	4	4	4	4	4	4	4	4	4	.4	4	4	
Exposure	All exposures maximum intensity.														

were sectioned. The pathological report is as follows:

Examination of slides from guinea pigs and cats exposed in the field of high-frequency current show mild degeneration and circulatory disturbances.

The central nervous system shows some congestion with small capillary hemorrhages and mild edema. The ganglion cells show varying degrees of haziness and indistinctness of cellular structure.

Sections from parenchymatous organs also show varying degrees of acute congestion and cloudy swelling.

Sections from denuded areas on the forelegs show coagulation necrosis of the epithelium with congestion, hemorrhage, and pus cell infiltration in the subcutaneous tissue resembling a burn.

The thermic influence, with which we are concerned, carried to its ultimate pathologic expression by repeated severe exposures would adequately account for the gross pathology observed either as a direct tissue necrosis or an indirect death of the part from trophic disturbance — changes in trophic centers or nerves, as conjectured by Tuve and Whitman.

Discussion

The figures relative to the degree of exposure of our human subjects can be only approximate, as the path of greatest current intensity was undoubtedly shifting and there was no way of accurately measuring or estimating the intensity of the eelctrical field to which they were exposed. It is quite certain, however, that except for the imposed condition of relative physical rest the factors in the tests determining physiologic reaction were made much more severe than is normal to ordinary working conditions. This was insured by the arrangements and evidenced by the history of symptomatic reactions. It was not possible, of course, to carry the human tests beyond this stage.

The majority of the symptoms complained of were merely heat effects as ordinarily experienced. With the possible exception of the prolongation of drowsiness and weakness, all the symptoms have been observed in the study of certain miners.

In still air in metal mines, with a wet-bulb temperature of over 90° F. and under 100° F., and with a relative humidity of 89 per cent or higher, the following symptoms were found, even when little or no exercise was taken:

TABLE II.—*Section 1.—Observations on exposure of volunteers to super-high-frequency currents*

	W-1	M-1	DA-1	G-1	G-2
Date and hour	Aug. 19, 1930.....1.20 1.54	Aug. 20, 1930.....10.25 11.00	Aug. 19, 1930.....10.20 11.00	Aug. 20, 1930.....1.19 1.54	Aug. 22, 1930.....10.26 11.08
Temperature, dry bulb:					
Before exposure	27 C.	25 C.	24.5 C.	26.5 C.	21.5 C.
After exposure	27.5 C.	26.5 C.	25.5 C.	27.5 C.	21 C.
Temperature, wet bulb:					
Before exposure	19 C.	19 C.	17 C.	18.5 C.	15.5 C.
After exposure	17.5 C.	19.5 C.	18.5 C.	18 C.	15 C.
Relative humidity:					
Before exposure	44.	83.	46.	44.	50.
After exposure	37.	47.	50.	39.	50.
Air flow	Slight draughts.	Slight draughts.	Slight draughts.	Slight draughts.	Slight draughts.
Barometer:					
Before exposure	29.96	30.04	29.85	30.04	30.08.
After exposure	29.94	30.05	29.86	30.05	30.06.
Current:					
Kilowatts	18.	18.	18.	18.	17.
Cycles	55,000,000.	55,000,000.	55,000,000.	55,000,000.	55,000,000.
Exposure, minutes	34.	35.	40.	35.	32.
First symptom:					
Minutes	Warmth immediately.	Warmth immediately.	Warmth immediately.	Warmth immediately.	Warmth immediately.
Progress	Increase.	Increase.	Increase.	Increase.	Increase.
Disappearance, current off	Immediate.	Immediate.	Immediate.	Immediate.	Immediate.
Before exposure:					
Temperature, pulse, and respiration.	98.2 78 14.	98.6 80 21.	98.4 78 14.	99.2 96 12.	98.6 84 12.
Blood pressure	108/70.	106/58.	116/78.	124/78.	110/76.
Second symptom:					
Minutes	Sweat, 5.	Pain, antenna wrist, 3.	Bone pain, antenna hand, 5.	Pain, 3.	Pain, 3.
Progress	General, from antenna hand	Increase.	Increase.	Increase.	Increase.
Disappearance, current off	Gradually.	Immediate.	Immediate.	Immediate.	Immediate.
During exposure, temperature, pulse, and respiration.	99 100 20.	Temperature 99 and 99.4; pulse, 108 and 114.	99.4 96 16.	Temperature 99.6 in 5 minutes; 99.8 in 20 minutes.	Temperature, 99.8 at 11.
Third symptom:					
Minutes	Pain, antenna wrist, 10.	Sweating, 5.	Sweating, 12.	Sweating, 5.	Sweating, 16.
Progress	Increase.	Increase.	Increase.	Increase.	Increase.
Disappearance, current off	Immediate.	Gradually.	Gradually.	Gradually.	Immediate.
Immediately after exposure:					
Temperature, pulse, and respiration.	99.8 90 11.	99.2 90 16.	99 84 17.	100.4 110 14.	99.5 84 14.
Blood pressure	110/60.	118/70.	110/70.	118/62.	110/82.
Fourth symptom:					
Minutes	Suboccipital headache, 29.	Drowsiness at 11.05.	Drowsiness at 11.05.	Weakness, 25.	Headache at 11.10.
Progress	Stationary.	Steady.	Steady.	Steady.	Increase.
Disappearance, current off	4 hours.	3 hours.	5 hours.	18 minutes.	2 hours.
One-half hour after exposure:					
Temperature, pulse, and respiration.	98.2 72 21.	98.4 82 14.	98.4 60 18.	99.8 96 13.	99.5 72 12.
Blood pressure	102/60.	102/58.	108/70.	112/74.	100/70.

NOTES

Column W-1.—Skin temperature, antenna hand, 40° C.; other hand, 35° C.
Column M-1.—Skin temperature, antenna wrist, 38° C.; other wrist, 32° C.; while mouth temperature is normal. At 15 minutes, mouth temperature, 99° F.; pulse, 108; at 27 minutes, temperature, 99.4; pulse 114.
Column DA-1.—Skin temperature, antenna hand, 34-35-40-C.; other hand, 29-31-36.6-C. After 4.30 felt only a normal type of fatigue, but more fatigue than usually experienced.
Column G-1.—At 3 p. m. no symptoms other than drowsiness, which disappeared at 4.30. At 3.30 developed frontal headache, duration 3 hours.
Column G-2.—At 12.05 p. m. headache, general weakness, and drowsiness. At 1 p. m. all symptoms present, but scarcely noticeable.

1. Blood pressure, systolic and diastolic, fell rapidly.
2. Body temperature rose; in one case it reached 102° F., and this after less than two hours having been spent in the hot, humid air described.
3. Pulse rate increased and seemed more sensitive to exercise than normally.
4. Perspiration was very profuse.
5. Dizziness was a common symptom and sometimes was marked.
6. Physical weakness or exhaustion was marked in some cases and present in all.
7. Inability to think quickly or accurately was a very common symptom.
8. Nausea was occasionally found.
9. Headache was also occasionally found.
10. Loss of weight was especially marked in men who had been employed under above conditions over a period of years, but occurred even after exposure only a few hours (10).

In our own observations three of the volunteers and the medical officer and medical technician, who are familiar with heat effects as encountered in the firerooms of ships, were in agreement that the late headaches, the prolonged drowsiness and general feeling of weakness or physical inertia are not experienced in exposures to mere thermic environment. Some different influence is expressing itself in the modified symptomatology and it is believed that the peculiar or specific is the difference between the surface application of heat, in the imposition of an additional load upon the heat-regulating mechanism, and its development within the body and the process of its production.

Whatever part of the field is occupied by the body, that part of it becomes a system composed of two condensers in series with a resistance. It is probable that the action is largely that of a dielectric, "in which electrons in the molecules of the body cells will, according to their state of freedom, either pass from molecule to molecule, first in one and then the other direction, or, if bound, are stressed in a direction the polarity of which alternates at the oscillator frequency."[4] The size of tissue cells would play a definite rôle in this as determining response to frequency, and the power behind a given frequency would determine the particular effect on cells of the responsive size. Although possible that, all conditions being favorable, a cell might be

ruptured by violent vibration no such effect has been reported, as far as we know. "It is known that the physiological effects of alternating currents can be profoundly changed by changes in frequency" and that "accompanying the change in the physiological response with increased frequency, there is a change in the path of the current through the tissues."[5]

As regards the symptoms other than pyrexia which seemed different from those experienced incident to exposure to surface heat, they are believed explainable as the consequences of this harmonic response "in the form of electromechanical vibrations of the living cell caused by the rapid alternation in polarity of the field."[4] They constitute the effects of a nerve and other tissue cell exhaustion influence of a purely physical nature decreasing the power of their return to functional normalcy depending upon severity of and interval between repeated exposures. In this connection, it is interesting and corroborative to note that repeated severe exposures at short intervals caused symptoms to occur earlier, to be more pronounced, and to last longer. Following the extreme daily exposure to which the volunteers were subjected, two of them reported that it took a month for the symptoms to wear off. Schereschewsky observed a similar delayed return to normal in the case of an assistant.

No previous observations or pointed tests concerning a possible health hazard affecting radio workers occupied with ultra high-frequency transmitters have been reported. Aid in the determination of the question is limited to the results of investigation with animal subjects and material of that sort is abundant and interpretable in terms of definite value to tenable conclusions in the present inquiry.

The results with our own animals have been set down in previous pages. The findings and expressed opinions of the several scientists who have been consulted are to the purport, with one exception,* that these currents are without ill effects apart from those accounted for on the basis of heat production and accumulation. Indeed, Christie and Loomis[5] maintain that the burden of proof still lies on those who claim otherwise. In this connection, by means of the incubator and water bath, they made an exact determination of what temperature *per se* could be tolerated by the normal mouse and found a close "agreement between that leading to death in these experiments and that resulting from the radiations." Other experiments with mice and frogs were performed to show that these currents are harmless apart from this heating effect.

In the work of Schereschewsky with transplantable tumors in mice, microscopic sections of the tumors removed after radiation gave a picture resembling coagulation necrosis.

The hairy animals, by virtue of their coat, suffer a definite handicap in heat regulation and the prompt lethal effects of induced extreme hyperpyrexia as well as the histopathological developments of thermic origin and character may be accounted for by that fact. The primary fatal effect is the expression of a body temperature out of proportion with the capacity of the heat regulating mechanism in safeguarding life; the histopathology is the expression of the effects of heat on protoplasm; and the symptoms the expression of physical trauma with reduced functional efficiency. A state of activity or quiesence in the subject and the atmospheric conditions (temperature, pressure, relative humidity, and air movement) are not unimportant factors under the circumstances of exposure to the heat-producing influence of high frequency radiations.

In the human subject also under similar extreme exposure and conditions conducive to heat accumulation there is the possibility of disturbance of the heat-regulating mechanism, centrally or in one of its components, with resulting uncontrollable body temperature movements after removal from exposure. This is a common observation in heat stroke and has been the observation in at least one case in which the therapeutic employment of high-frequency radiation overreached tolerable limits. But whatever the degree of exposure, heat production by rapidly alternating induced electric currents within a highly specialized living organic resistance is attended by a temporary greater or less impairment of function, due to a tiring of the cellular element of the tissues by electromechanical vibration, which in the human subject becomes available, in building a picture of the complex reaction, as subjective symptoms.

There seems some variation in the subjective evidence of reaction though not necessarily in susceptibility, according to the nerv-

* Mellon et al. (6).

TABLE II.—*Section 2.—Observations on exposure of volunteer (Dr.) to super-high-frequency currents*

	DR-1	DR-2	DR-3	DR-4	DR-5	DR-6
Date and hour	Aug. 18, 1930, 1.10 to 2.35.	Aug. 19, 1930, 11.30 to 12.	Aug. 20, 1930, 11.26 to 12.20.	Aug. 21, 1930, 10.22 to 10.45.	Aug. 21, 1930, 1.27 to 1.40.	Aug. 22, 1930, 10.35 to 11.05.
Temperature, dry bulb:						
Before exposure	26.7 C.	26 C.	26.5 C.	24 C.	26 C.	21.5 C.
After exposure	28.9 C.	26 C.	27 C.	25 C.	26.5 C.	21 C.
Temperature, wet bulb:						
Before exposure	22.8 C.	18 C.	19.5 C.	18 C.	18.5 C.	15.5 C.
After exposure	20.6 C.	19 C.	20 C.	18.5 C.	18.5 C.	15 C.
Relative humidity:						
Before exposure	67	44	50	55	47	53.
After exposure	43	50	50	53	44	53.
Barometer:						
Before exposure	29.86 29.92	29.86 29.98	30.05 29.84	30.08 29.76	30.08 29.76	30.06 30.04.
After exposure	28.6 29	29.85 29.98	30.05 29.84	30.08 22.76	30.00 29.76	30.08 30.04.
Current:						
Kilowatts	16	18	18	18	18.5	17.
Cycles	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000.
Exposure, minutes	35	30	34	On 13, off 4, on 6. Total 19.	22	30.
First symptom:						
Minutes	45 seconds	Immediately with joint pain.	Warmth immediately.	Immediately	Immediately	Immediately.
Progress	Progressive	Progressive	Increase	Increase	Increase	Increase.
Disappearance, current off	Immediate	Immediate	Immediate	Immediate	Immediate	
Before exposure:						
Temperature, pulse, and respiration.	99.2 80 20	98.2 82 18		98.6 76 16	98.4 84 14	98.2 72 15.
Blood pressure	118/60	94/62		108/58	108/66	104/60.
Second symptom:						
Minutes	1	10	10	5	5	16.
Progress	Progressive	Progressive	Increase	Increase	Increase	
Disappearance, current off	Immediately	Immediately but gradually.	Immediately	Immediately	Immediately	
Immediately after exposure:						
Temperature, pulse, and respiration.	99.4 80 22	99.1 78 20	99.6 84 16		99.2 84 16	99 76 16.
Blood pressure	120/70	106/70	104/70		134/90	102/58.
Third symptom:						
Minutes	5	10	30	10.50	Augmented for 2 minutes.	Augmented immediately.
Progress	Steady	Steady	Steady	Steady	Steady	Increase.
Disappearance, current off	Continued until asleep, 9 p. m.	At 4.30 p. m.	7.30 p. m.	12.30 p. m.	6.30 p. m.	Slowly to steady ache.
1 hour after exposure:					(½ hour after.)	(½ hour after.)
Temperature, pulse, and respiration.	98.4 75 21	98.0 78	98.4 72 16		98.6 78 16	98.6 76 18.
Blood pressure	110/80	90/60	104/86		100/60	110/76.
Fourth symptom:						
Minutes	5	10—legs only	10	5	5	5.
Progress	Worse	Steady	Steady	General to steady	Began in legs then thru body.	Steady.
Disappearance, current off	Continued until fell asleep.	Persists	Improved after 7 p. m.		Continued	
Temperature, pulse, and respiration.						Mouth temperature 99 at 11.05.

NOTES.—Body weight before and after exposure, no change. Aug. 18, 1930, weight 149; Aug. 22, 1930, weight 147½; Aug. 25, 1930, weight 146.
First symptoms: Heating of left (antenna) hand followed by both feet, head, and body in order named.
Second symptoms: Sweating; skin temperature.
Third symptoms: Headache, frontal and bitemporal—not throbbing.
Fourth symptoms: Weakness general.
Column DR-1.—Skin temperature antenna, hand 37° C.; other hand, 34° C. Discomfort—weakness, drowsiness, and headache, continued until 9 p. m. when he fell asleep, this despite a nap at 6 p. m.
Column DR-2.—Temperature, 99 in 25 minutes. Only symptom persisting after 4.30 p. m. was general weakness which carried over to test on Aug. 20, 1930.
Column D-3.—Temperature 99 in 15 minutes, 99.4 in 20 minutes. At 2.30 p. m. normal except for headache and slight weakness.
Column DR-4.—Body and head did not get warm. Machine broke down.
Column DR-5.—The pain comes earlier and is more intense. 2.15 p. m., soreness in wrists and ankles, and weakness, drowsiness, persists with dull headache.
Column DR-6.—The pain in legs disappears with changing position in electrical field. Pain in wrists and ankles developed immediately with weakness. Pain in knees in 20 minutes. Tremor on exertion. Only symptoms at 1 p. m. slight headache and weakness and soreness of wrists, ankles, and knees.

ous or phlegmatic inclination of the temperament of exposed persons. This was noted by Schereschewsky as between himself and an assistant and by ourselves in the volunteer human subjects among whom there appeared a difference in development, severity, and persistence of symptoms. The nervously sensitive type gave a more pronounced picture, aside from any proneness of a given individual to exaggerate. This was also the case in our human subjects, other things being equal, with those of taller stature and fairer complexion.

The foregoing data and discussion has to do with the effects and results of extreme exposure to superhigh-frequency radio currents as they bear upon the conclusions we are called upon to express. The electrical exposure of our human subjects was raised to an intensity, though unmeasured, much in excess of that normal to regular working conditions, while, as far as controllable, in other factors having conjectural influence in augmenting or modifying the electrical effects, the normal was sought. The electrical exposure of our animals was controlled and calculated, as far as is possible in using the field between condenser plates, and was raised to a degree of intensity consistent with tolerance, differing in each group for purposes of comparative study. The symptomatic and structural effects of sublethal doses have been described.

Relative to the particular point of frequency *per se* which is naturally injected into the question by the qualifying term "high" in the subject title, Schereschewsky is of opinion that frequency has an important bearing upon lethality while Christie and Loomis believe "that the lethal nature of these radiations is proportionate to the intensity of the field up

to a frequency of about 50,000,000 cycles."[5] However, maximum reaction, whether explained on the basis of frequency or intensity, does seem to be identified with a frequency in the neighborhood of 50,000,000 cycles (wave length, 6 meters), which is approximately the natural period for quarter-wave oscillation of an antenna the length of the human body. This is about the frequency with varying power at which some of our tests were conducted. There seems to be agreement that in higher frequencies there is diminution in reaction and in this connection it is recalled that, in the history of previous exposures of personnel at the Naval Research Laboratory, no subjective distress was experienced by those working with one-half to 2 kilowatts and frequencies up to 75,000,000 cycles. Complaints came from those working with higher power (10 to 20 kilowatts) which seems to suggest the predominating importance of intensity, although in studying a subject included within the broad band of radiant energy we can not evade the idea that frequency plays a specific part in the observed effects. To play such a part it need not do other than produce the electromechanical vibration above considered, but even in this the influence of intensity can not be ignored.

Our inquiry has brought to light no case, either in laboratory experimentation or radio work anywhere, of injury to a human being by the temperature effects of high frequency or otherwise. E. F. W. Alexanderson, of the General Electric Co., points out that "in order to induce fever of any consequence it is necessary to use quite a special arrangement" to insure definitely the exposure of the subject to the effects of a high frequency alternating current. The observations of Whitney in this respect have already been mentioned.

In most work with radio transmitters, as at the Naval Research Laboratory, on board ship and elsewhere, one antenna is used and not a condenser field in the ordinary sense. The experiments with our volunteers at the Naval Research Laboratory were, proper to the determination we were asked to make, under arrangements and conditions representing a mere exaltation of those normal to routine work. The intensity and frequency of the current were such as to produce maximum effect and yet the reaction in terms of fever was generally less than 1° F.

The severest exposure under conditions which ordinarily obtain at the Naval Research Laboratory incident to work in the immediate vicinity of high-powered short-wave oscillators may be expected to produce only moderate transient subjective symptoms of the character described, slight lowering of blood pressure, and slight increase of body temperature.

Conclusions

Answering the specific question, viz., "What dangers to human health, if any, are likely to result from the use of super-high frequency for radio communication?" our opinion is that from a practical point of view there are none.

In expressing this opinion we are limiting ourselves to the subject as involved in the present and probable future normal exposure of Navy personnel and employees either in the development and testing of high-powered transmitting apparatus at the Naval Research Laboratory or elsewhere and their operation in the service ashore or on board ship wherever installed. That is clearly the Navy's primary interest in the matter and the background of the inquiry.

Both directly and by inference we have discussed the degree of exposure in connection with the development and testing of apparatus fabricated at the Naval Research Laboratory. Exposures to induced fields of radiant energy, incident to tuning up and operating installed apparatus, are even less severe in respect to time and intensity. In either case the field is variable and not concentrated and the transmitter sets installed on board ship are somewhat less powerful than that at the Naval Research Laboratory. Moreover, the transmitters in regular service are inclosed in metal cabinets and consequently electrically shielded; where as the transmitters in the laboratory are held in open experimental construction and consequently not shielded. In other words, radiation from various parts are suppressed in the one but not in the other, so that exposure to uncomfortable symptoms is much less likely, if at all likely, with service machines.

As regards the transient discomfort, and hence reduced efficiency of the laboratory force concerned, it may be minimized by attention to certain factors observed in the course of our investigation.

TABLE II.—*Section 3.—Observations on exposure of volunteer (Y) to super-high-frequency currents*

	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6
Date and hour	Aug. 18, 1930....10. 30 11. 20	Aug. 19, 1930....11. 30 12. 00	Aug. 20, 1930....11. 26 12. 01	Aug. 21, 1930....10. 22 10. 45	Aug. 21, 1930....1. 27 1. 49	Aug. 22, 1930....11. 09 11. 39
Temperature, dry bulb:						
Before exposure	25 C.	26 C.	26.5 C.	24 C.	26 C.	21 C.
After exposure	27 C.	26 C.	27 C.	25 C.	26.5 C.	21.5 C.
Temperature, wet bulb:						
Before exposure	17 C.	18 C.	19.5 C.	18 C.	18.5 C.	14.5 C.
After exposure	20 C.	19 C.	20 C.	18.5 C.	18.5 C.	15.5 C.
elative humidity:						
Before exposure	44	44	50	55	47	50.
After exposure	50	50	50	53	44	53.
arometer:						
Before exposure	28.8 29.4	29.86 29.98	30.05 29.84	30.08 29.76	30.08 29.76	30.08 30.04.
After exposure	28.6 29.2	29.85 29.98	30.05 29.84	30.08 29.76	30.06 29.76	30.08 30.04.
Current:						
Kilowatts	10	18	18	18	18.5	17.
Cycles	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000	55,000,000.
Body weight, 145						146.
Exposure (minutes)	10 on, 4 off, 35 on; total, 45.	30	34	13 on, 4 off, 6 on; total, 19.	22	30.
First symptom:						
Minutes	No antenna held until after 10.	Immediately	Warmth immediately.	Warmth and pain in wrist stat.	Warmth and pain antenna wrist.	Warmth and pain antenna wrist.
Progress	Stationary.	Progressive		Increase	Increase	
Disappearance current off	10 minutes.	Immediate.		Immediate	Immediate	
Temperature, pulse, respiration:						
Before exposure	98.8 84 20.	98.4 78 16.	98.6 66 16.	98.4 72 18.	99 72 22.	98.3 60 18.
After exposure	100 88 30.		100 84 20.		99.4 84 20.	100 84 20.
Blood pressure:						
Before exposure	130/92	130/80	128/88	120/86	124/94	116/92.
After exposure	118/90.		128/94		134/94	134/90.
Second symptom:						
Minutes	1.00 p. m.	15.	Pain legs 5.	Sweating 5.	Pain in wrist.	
Progress	Stationary.	Progressive.	Increase.	Increase.	Immediate increase.	
Disappearance current off	During sleep after 9 p. m.	Immediate but gradual recovery.	Immediate.	Immediate.	Immediate.	
Temperature, pulse, respiration		12 noon, 99.7, 84, 20 12.15 p. m., 99.8, 84.	12.30 p. m., 98.8, 78, 18.		1.15 p. m., 99, 68, 20.	99.2 72.20.
Blood pressure		12 noon, 120/98. 12.15 p. m., 124/90.	1.30 p. m., 120/70.		2.15 p. m., 120/90.	12.10 p. m., 120/94.
Third symptom:						
Minutes	1.30 p. m.		Weakness at 12.05 p. m.			
Progress	Steady.					
Disappearance current off	9 p. m. required aspirin, in sleep.					
Temperature, pulse, respiration			2.30 p. m., 99, 84.			
Blood pressure			2.30 p. m., 122/92.			
Fourth symptom:						
Minutes		Bone pains after 7.	Bone pains in 2.	Bone pains immediately.	Bone pains immediately.	Bone pains and pains in legs.
Progress		Became excruciating.	In antenna hand and both legs. Increase.	Increase.		Immediate increase.
Disappearance current off		Immediately on releasing antenna.				Immediately.
Temperature, pulse, respiration	99.3 78.					
Blood pressure	120 80.					

Notes:
* First symptoms—Warmth R. (antenna) hand followed by general body warmth after 20 minutes and feet warm after 30 minutes.
* Second symptoms—Weakness, 1 p. m.
* Third symptoms—Headache, 1.30 p. m. (* Column Y-1.)

* Y-1—At 3 p. m. above improving.
* Temperature, pulse, respiration—99.3 at 4 p. m., rose to 99.7 at 6 p. m., fell to 98.6 at 9 p. m., 98.6 following day.
* Practically no sweating during test. (Naturally sweats practically none.)
* Feels that S. H. F. is different from high temperature heat as heat seems generated on outside and distributed by blood.
* Skin temperature antenna arm 37° C., other arm 30° and then 32° C.

Y-2.—Temperature 99 in 6 minutes; 99.2 in 15 minutes; 99.4 in 25 minutes. 2.30 p. m. a gradual improvement in all symptoms has continued. Feels only tired now. Temperature 99 at 2.30 p. m. Temperature normal at 5 p. m.

Y-3.—Temperature 99.2 in 15 minutes; 99.6 in 20 minutes. 12.30 p. m. temperature 99.4, feels exhausted. At 2.30 feels normal except tired. Exhaustion disappeared after lunch. Temperature and feeling normal after 3 p. m.

Y-4.—At 10.30 temperature antenna wrist 35° C. other wrist 31° C.

Y-5.—At 1.40 p. m. skin temperature antenna wrist 37° C. other wrist 33° C. 2.15 p. m. normal except for drowsiness. Temperature normal after 3 p. m. Drowsiness continued until retired.

Y-6.—The pain in the wrists and legs occurred earlier and was more intense. A good sweat began at 15 minutes. Felt normal at 12.15 p. m. Believes he gets symptoms earlier but they leave quicker. Appetite continues O. K. After 5 days' exposure there were no cumulative effects noted.

(a) The removal from the possible induction field of anything which might operate as a second antenna or electrode and thus to intensify and concentrate the field.

(b) The reduction of testing time to the actually essential and not "idling" the apparatus with personnel near by.

(c) The erection of such electrical screens as will not interfere with the work, yet provide the maximum shielding.

(d) As far as may be possible, the employment of men on the work with reasonable regard for the temperamental and physical qualifications which seem to reduce susceptibility.

(e) As far as may be possible, the selection of days for testing which are characterized by atmospheric conditions favorable to body-heat regulation or secure air movement to that end by artificial means.

(f) As far as may be consistent with requirements, the avoidance of the 50,000,000-cycle frequency (6 meters) which has been suggested as the critical period.

(g) Provision for the distant control of transmitters.

For purposes of future study it would be useful if the laboratory would keep individual running records of reaction in relation to frequency and intensity of current and time (period) of exposure in the field of the oscillator.

Acknowledgments

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E D I T O R I A L S

ULTRA-HIGH FREQUENCY THERAPY —A NEW POSSIBILITY

Physical Therapy is now entering into a new phase of endeavor the possibilities of which we predict will be far reaching in result. Increasing data regarding the action of ultra-high frequency oscillation on biologic structure indicates the usefulness of this field of irradiation in therapeutics. A new opportunity is knocking at the door of Physical Therapy and should be given all possible chance to attain vigorous prestige through the exacting labors of scientific research.

Looking back on its accomplishments we all have reason to congratulate its pioneers on the data already accumulated. The physical facts regarding ultra-high frequency circuits are already well established and are based upon definite mathematical principles. There is no mystery regarding the method of producing these ultra-high frequency radiations. De Walt[1] in a recent paper said, "We know that the process follows well known laws and that electrically there is nothing at all mysterious in the heating or in the apparatus used in its production."

The temperature raising properties by means of such circuits still remains a spectacular demonstration if not a mystery. But no matter how it may for the moment appeal to our minds, of greater import is the growing enthusiasm for the method in producing and controlling artificial fever. It is at present becoming highly accepted as the safest method of inducing hyperpyrexia in dementia paralytica cases. Not only does it eliminate the dangerous feature of malaria inoculations but it will prevent the frequent deleterious overflooding in these patients of consequent toxic agents.

Reliable work has already been accomplished to definitely indicate the general physiologic trend of these reactions in cases of animal and human experimentation. Whitney[2] was probably one of the earliest investigators to appreciate a new possibility in these radiations when he used a small induction type of heater in the attempt

to grow artificial galls on plant stems. Shortly afterwards and with modified and improved apparatus the same author observed an elevation of body temperature in men working in the field of ultra-high frequency high power oscillators. Gosset, Cutmann, Lakhowsky and Magron[3] were among the first of foreign collaborators to add suggestive information to this sphere of biophysical investigation.

The possibility of these short frequency radiations as a means of combating cancer was early suggested by Schereschewsky.[4] Hope was aroused that within these limits of radiation a new specific wave length was to be found lethal to cancer cells. Unfortunately, this premise enjoyed but short popularity due to the investigations of Christie, and Loomis,[5] who proved beyond peradventure the absence of specific frequency as related to cancer. From the foregoing data as well as from the experiments by Wood and Loomis,[6] Hosmer,[7] Kahler, Chalkley and Voetglin,[8] all have demonstrated that the phenomena observed so far can be explained as due to heating (and probably to some other factor as yet unexplainable) produced by radiation. Whatever its nature, the unique character of these heating effects and the peculiarities of their production are finding wide application in curative medical science.

The work of Carpenter[9] suggests that a new approach may possibly be found here in the treatment of syphilis irrespective of type or age. Studying the effects of ultra-high frequency in a group of 25 luetically infected rabbits, 21 "showed no lesions (no chancres). Five of this group developed nodules in their testes, the size of a pea, during the treatment; but by lengthening or intensifying the exposures the lesions disappeared." The Wassermann and Kahn tests showed a parallel reduction in the treated animals. Animals sacrificed by overheating and autopsied immediately showed that the temperature distribution was not limited to surface areas. It raised the temperature of the deeper organs such as liver, heart and kidney by two or three degrees (F.) higher than the other tissues under similar influence. The liver, however, always showed the highest temperature by one or two degrees (F.), and maintained that level above the other organs of the body. Neither growth[10] nor fertility seem to be retarded under these irradiations, nor does it produce any abnormal pathologic lesions when the heating is extended up to the range of 104.9° F. When the temperature level is high but compatible with life the blood chemistry and the blood forming tissues are influenced. The tissues become noticeably dehydrated. There is a decrease in blood volume and an increase in the blood concentration. The blood sugar and carbon dioxide are reduced, the non-protein-nitrogen is increased, in some cases over 200 per cent, and there is a definite increase in the morphology of the red cells, suggestive of immature formation.

Obviously, consistent changes of a physiological nature can be invoked by these ultra-high frequency oscillations to warrant an optimistic attitude regarding the future possibilities of these particular wave lengths in treatment of a large variety of conditions. Conviction is becoming more firmly established that many beneficial effects can be provoked through the general systemic heating of the body. In the light of earlier teachings regarding fever and the measures advocated to circumvent its presence one realizes now the radical shift in the attitude of present day medicine regarding its endogenous qualities. Medical science is apparently beginning to view the presence of fever as a benign effort of nature.

Interesting new data has recently been further added to this fascinating field of research by Bell and Ferguson[11] of the United States Navy. While their studies were directed to determine the effects and possible hazards to the health of men exposed to the field of influence of super-high frequency radio transmission current, the facts discovered through this piece of research is of extreme value in two directions. It confirms the physiologic nature of ultra-high frequency currents and points to a means whereby the influence of these currents could primarily be made local in action as well as general. Their experiments were with radio aerials rather than the General Electric condenser plate type of apparatus used by other workers. The men exposed to this field of radio wave influence acted as an antenna to these rays and soon began to experience sensations of heat in the lower extremities which later became general in effect. Upper extremities could in a like manner be heated first by placing the hand in contact with a 40 inch metal rod which rested upon a metal fence acting as a

ground. According to the authors, the subjective symptoms elicited by these experiments were as follows:

The first symptom of warmth in the antenna hand occurred immediately. After three to five minutes the discomfort became so intense that it would be necessary to shift the antenna to the other hand. The sensation of warm would be next felt in the feet and ankles, then the body generally, then about the head.

The second symptom usually was a cramplike pain felt in the bones or tendons of the wrist of the antenna hand. This usually appeared in about three minutes. It rapidly attained excruciating proportions. It disappeared immediately on releasing the antenna. Local muscular weakness accompanied the pain. The pain could not be localized. It was not a joint pain. There was no evidence of tetany or spasm of the muscles of the forearm. In some the pain seemed superficial, being increased by pressure. In others, all degrees of external pressure had no effect on the pain. A pain of the same character would sometimes be felt in the ankles.

The third symptom was sweating. It followed the same course as the sensation of warmth. In only one of the six exposed was the sweating described as exhaustive.

The fourth symptom was either weakness, drowsiness, or headache. Nothing characteristic was elicited about these symptoms. The weakness was general; it was that of fatigue rather than exhaustion. The drowsiness was of the normal type. The headache varied in location, in character, in intensity, in duration, and it was unassociated with blood pressure, pulse rate, or degree of temperature elevation.

From what has been said above it is obvious that high frequency therapy is now undergoing a further transitional stage in development. During the span of its forty years of existence it has gradually established itself as a material factor in the treatment of indolent and chronic disease. It is not at all unlikely that pyretotherapy will be adapted by the medical profession as a valuable adjuvant to the other measures already well established. For its systemic effect the double plate condenser electrodes will materially simplify present day technic. The antenna-like technic of Bell and Ferguson for local effects is suggestive of some very interesting possibilities. These innovations appear to be the very means of rounding out the many difficult steps encountered in the application of diathermy to irregular surfaces.

The time is now propitious to transfer our laboratory experimentation with ultrahigh frequency currents to the bedside of actual cases. We feel confident that under intelligent and conservative administration this new field of radiation will demonstrate its worth in a large variety of abnormal states.

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ADVANCES IN ELECTROSURGERY

Sufficient data has now been collected regarding the value of electrosurgery to warrant the enthusiastic claims advanced for it. The method is now no longer classified as a questionable and novel form of surgery. Its usefulness as well as its importance as a special surgical procedure is now often cited in medical literature. Its indications are gradually becoming more extended with increasing experience and the perfection of apparatus. Accessibility of the neoplasm is no longer the sole indication for its use; nor is malignancy the only excuse for electrosurgical extirpation.

There is now sufficient evidence to indicate that future electrosurgery will gradually be adopted, according to the hope of Kelly,[1] "to fields where the scalpel and ligature have failed in efficiency as in operations on the head, the chest and the neck, advancing into the depths, awkward in their performance and involving delays, manipulations, and probable contaminations and undue hemorrhage; cases in which we often try to counteract the soiling of the wound by free drainage; a group dreaded on account of that uncertain point

at which we are likely to meet the *ne plus ultra* barrier."

That Kelly is an enthusiastic disciple of the new surgery can readily be concluded from his publications. It is his belief that electrosurgery is a definite contribution because of its ability to provoke certain beneficial actions absent in classical surgery. "It is a tremendously effective sterilizing agency; it does clean work of a supreme order; it is a knife and fork procedure, avoiding finger contact and leaving a delectable, dry, smooth field; it is rapid; there is less shock, followed by a comfortable convalescence with fewer inflammatory sequellae; it is, therefore, far less formidable, and our patients are oftener ambulant, thus enlarging hospital bed facilities."

His paper, published elsewhere in this issue is an earnest plea for more universal adoption of electrosurgery, and no doubt will have a stimulating effect on his many disciples. His plea for a more tolerant attitude is based upon a rich experience with the method. As one of the earliest users of electrocautery and fulguration he has seen the gradual displacement of these by means of the high frequency cutting and coagulating current. His enthusiasm must, therefore, be accepted as an index of mature judgment and given due consideration.

The surgeon, however, who has had nothing more than a scalpel experience will often meet with disappointment until he masters the special technic associated with the work. It is not a difficult technic to master, but without it, the results are most often questionable, if not disappointing. The various actions of modern high frequency current should be under definite control of the surgeon during operation. The surgeon should have a thorough understanding of how to control the different effects such as desiccating, fulgurating, coagulating and cutting. One not experienced with the method of regulating these effects often has depreciated electrosurgery on the basis of its uncontrollable reaction, i.e., delayed healing, overcoagulation and overstimulation of malignant tissue. It is not a panacea, therefore, in the hands of blundering surgeons. Its frequent use by the adventurous in the profession has been the most frequent handicap in retarding its recognition by those most competent to use it with greatest effect. It is the method of choice for only those that are duly recognized for their surgical ability and experience.

In spite of the many handicaps that have been placed in its path, one sees in the growing popularity of electrosurgery the tolerance of a profession singularly able to differentiate potential possibilities from early crudities. Its more frequent use in accessible malignancies is a gratifying index of its more universal recognition. Indeed, surgery is no longer limiting its indications to this field alone. Otolaryngologists have for some time called attention to the usefulness of the method in certain conditions of the throat. According to Hollender,[2] fractional electrosurgical extirpation of tonsils is probably one of the safest methods to use in the tuberculous patient, and affords a new method for relief of toxic foci in these difficult cases. This same author has in another publication[3] also advocated the conservative use of electrocoagulation for the destruction of tonsillar plica and exuberant lymphoplastic tissues. As in other surgical specialties the early recommendation of electrosurgery was received with deep suspicion by its recognized leaders. There is today a more tolerant attitude towards this procedure and bids fair to be generally adopted.

A recent expression of the attitude of otolaryngologists toward the general usefulness of this new surgery may be gleaned from some of the remarks by Odeneal[4] in a recent publication:

> Coagulation is unquestionably the method of choice, and the tonsils are successfully removed in from three to five or more treatments. A clean throat is left; the tonsillar fossae are smooth and the pillars untouched and, so far as can be seen, the capsule is destroyed. When one removes the tonsils to eradicate an acute complication, such as arthritis, an improvement is often noticeable after the first treatment. The absence of postoperative hemorrhage is one of the advantages mentioned for removal of the tonsils by diathermy. This complication, however, has occurred on several occasions in my experience, twice severely; in one case it was necessary to suture the tonsil. This is rare, however, whereas slight hemorrhages are comparatively frequent. Formerly I removed the tonsils in four sittings, treating both tonsils at one sitting. It is now my custom to treat only one tonsil alternately, at weekly intervals, and to give six treatments, or more if required, to each tonsil. The reason for lengthening the period of treatment is to prevent too much sloughing of the tissues and resultant bleeding, and also to reduce the pain after treatment. If one tonsil is treated at a time the patient is not so uncomfortable between treatments.

All indications, therefore, point to a more favorable adoption of electrosurgery in future medicine. We are in accord with Kelly in "urging that we one and all expand the field of electrosurgery by putting it to wider uses, even where the presumptive advantages are not obvious, in order to achieve that spontaneous *finger-fertigkeit* which passes into a second nature, an instinctive habit, a sort of subconscious electrosurgical sense that paves the way for and conducts readily into new fields wherein lies hopes of surprising discoveries."

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Heart of Matter Alpha Particle Tetrahedrons Build Up Atom Nucleus

Scientists were given a look into the heart of matter and shown diagrams of the structure of the atomic nucleus when Prof. Wendell M. Latimer of the University of California presented to the American Association for the Advancement of Science meeting at Pasadena, Calif., a new theory of the way in which the central portion of the atom is put together.

This is the ultimate and final step determining just what is the structure of the material things about us. In the past few years scientists have carried their probings into the makeup of matter step by step into the realms of the minute in size. Beneath the seemingly solid surfaces of metals and other substances with which we have daily contact, they first found a multitude of regularly arranged crystals, row on row of them, each made up of molecules, which in turn were shown to be definite arrangements of atoms. X-rays have aided greatly in this exploration of submicroscopic crystal worlds. The atom was shown to be fashioned as a very heavy nucleus surrounded by very light particles or waves known as electrons. Prof. Latimer has assumed the task of discovering the architecture of that internal citadel of the atom which has kept out prying scientific explorers.

Previous investigators have pictured the nucleus of the atom in terms of the number of protons, or hearts of hydrogen atoms, and electrons that are present, Prof. Latimer explained. In iron, for instance, the necleus was known to consist of 56 of the protons, as the hydrogen nuclei are called, and 30 electrons or units of electricity. The radio-active disintegration of elements like radium gave a clue to how the protons and electrons were arranged in the nucleus. Disintegrating matter gives off both unattached electrons in pairs and bundles of four protons and two electrons known as alpha particles. These particles are known to be also the atomic hearts of helium, the inert gas that is used to inflate American airships. Other research has shown that these protons and electrons are spinning and opposite spins play an important part in keeping the nucleus together.

These were the materials used by Prof. Latimer in building together his new view of the heart of matter. First he arranged alpha particles in a tetrahedral pattern, that is, at the corners of a triangular pyramid. Then he assumed that each of these alpha particles is itself a tiny tetrahedron of four protons with a pair of electrons happily spinning at its center. This builds a nuclear structure that satisfies all science knows about the atomic nucleus. Prof. Latimer presented it as the best picture that can now be drawn of the ultimate in the structure of matter.—*Science News Letter,* June 27, 1931.

PHYSICAL THERAPY CLINICS

IMPORTANCE OF PHYSICAL THERAPY IN EARLY TREATMENT OF INJURIES *

HEINRICH F. WOLF, M. D.

NEW YORK

In medicine as in any other branch of endeavor, efficiency is defined as the ratio of energy expended to results obtained. There have always been efficient and inefficient methods. It is only within the past few decades that industry has adopted efficiency as a part of its practice. In America and other progressive countries it has come closest to what is understood as a science.

While a scientific application of efficient principles is considered an economic necessity, nobody has heretofore applied this conception to the practice of medicine. It is by no means a coincidence that the problem of efficiency becomes apparent in the practice of physical therapy. No matter how intensively we have studied the action of drugs in the past, the old time pharmacy was not the proper field for efficiency because the action of drugs was mainly empiric. In physical therapy, on the other hand, we are dealing with an agent which is not only known with as much exactness as human science can supply, but one where the action on the organism can be determined with sufficient accuracy. We know that with heat we can dilate blood vessels and produce a hyperemia; that we can stimulate a muscle with interrupted electrical current, etc. Besides, not only the applications but the effect of physical therapy is mostly local. With electrical applications the problem of paramount importance is the location of the application, the intensity of the treatment and the stage of the pathological condition. An illustration will elucidate in the simplest way what I want to say. By using a method belonging to the field of physical therapy, I am only expressing the fact that physical therapy with its employment of physical methods shows it most clearly. You know that in using a plane for the purpose of leveling a piece of material, metal or wood, the principle of efficiency requires that we use a plane which will cover the entire surface, and in this way do the work in one single movement to avoid waste, as a waste of motion is a waste of time and effort. Those of you who have had occasion to watch masseurs must have seen that according to most of the systems of massage the operator is using single individual fingers in the treatment, though it is obvious that by employing the hand with outstretched fingers including the palm of the hand he can do with one stroke what would take ten strokes if the individual fingers were used, according to the old infficient system now in use.

But inefficiency can show itself not only in waste of time and effort, but by the neglect of using the opportune time for actions. If one digs earth and wants to cart it away, one does not dig the earth, shovel it out and then allow it to settle again but it is carted away while it is still loose.

Before applying these principles to the treatment of injuries, we must give a thought to the system by which the organism works in its self cure. Here we must first divest ourself of the belief that the organism in its healing efforts does always the best. On the contrary we will find that its best is often the worst as far as the functional result is concerned. Another illustration will help to make this statement clear.

Most injuries are accompanied by a rupture of blood vessels, by an internal hemorrhage. The blood, liquid in the beginning, gradually coagulates, becomes more and more organized and is then gradually absorbed. It is evident that the absorption

* Read at the Ninth Annual Meeting of the American Congress of Physical Therapy, September 8th to 12th, 1930, St. Louis, Mo.

will be slower the farther the organization of the extravasation has progressed. The result in the removal of the wreckage shows that the procedure of the organism was inefficient and that the ultimate result would have been better if the organization of the extravasated blood would not have gone so far. The best proof for this contention is that the internal hemorrhages in bleeders in whom the blood does not coagulate heal proportionally very quickly, though they easily recur.

Keeping these facts in mind we can show that the usual early treatment of such injuries is very faulty. To put hot applications on an injured part immediately after the injury, dilates the blood vessels and increases the hemorrhage, while cold applications or immediate compression prevents or minimizes the hemorrhage and in that way reduces the extent of the injury. On the other hand, immobilization without active treatment after the first shock of the injury is passed, will lead to the organization of the exudate and make it more difficult to bring about an absorption and accomplish a cure.

We may call this form of treatment an internal debridement, which corresponds to the debridement used in open wounds since the war. Of course, I am fully aware of the fact that by debridement in the later sense we mean a removal of dead and injured tissues which would otherwise offer a fertile field for infectious organisms.

The methods mentioned in these few words form a part of preventive medicine. Preventive medicine does ont only mean that the best procedure in dealing with human beings is to prevent them from becoming sick. We may call it preventive medicine to minimize as much as possible the damage done by organisms as well as by injuries through violence; and in this way we may include all those procedures which will prevent the organism from going too far in its groping effort for a cure. The best treatment of an ankylosis of a joint is to prevent it by such methods which bring about a cure before more or less irreparable damage has been done. It is a tremendous waste of energy to allow a stiffening of the joint after a fracture in its neighborhood, instead of trying to repair the damage in it and maintain function.

I have intentionally set these ideas down in a very general way. I cannot state emphatically enough that a routine approach in the direction of early active treatment is nearly just as bad as the treatment usually employed by the general surgeon. We must always keep in mind that it is the duty of the physician to assist nature in its curative efforts, but to assist nature does not mean meddling with it, it means as well to help it as to lessen its activity. As long as we see that the organism does, what it ought to do, efficiently, we must abstain from interference. To be able, however, to do this efficiently, it will be necessary to analyse each individual case from the standpoint, not only of the injury and its location, but most of all in consideration of the reaction of the body. I cannot believe as so many prominent physicians do that an inflammatory process is a favorable thing no matter how strong the inflammation is, and that the inflammatory process can never be strong enough. I have proved to myself and to others conclusively that the reduction of the intensity of the inflammatory process may have a most salutary effect by preventing the formation of inflammatory tissue. There is no method as sovereign and as efficient in its action in all these cases as physical therapy, and it is very unfortunate that there are very few surgeons willing to accept these methods for their preventive value. I have pointed out how favorable it is for a cure if immediately after an amputation of a gangrenous foot, continuous radiant heat is applied. The hyperemia resulting from it would hasten the cure by primary intentions, while it is unable to cope with an infection once it has taken place. It is my conviction that the routine use of radiant heat after abdominal operations would hasten the absorption and prevent adhesions. The treatment of an acute acromioidal bursitis which stops the inflammatory process within a few days will prevent in all cases the development of ankylosis by adhesions in a bursa.

The remarks made above should only constitute a suggestion as to the course to be followed. All that I intend to do is to bring this point of view before you for discussion, as the execution of its principles lies mainly in the hands of the physical therapist.

CURRENT NEWS AND COMMENT

Municipal Hospital of Radiology and Physical Therapy

The Instituto Municipal de Radiologia y Fisioterapia, a radiology and physical therapy hospital, one of the largest in the world, has been inaugurated at the federal capital of Argentina. Dr. H. Carelli is the director. The six story building covers a surface of 10,000 square meters at Parque Centenario and cost 1,050,000 pesos ($1,018,500). The departments of phototherapy are a replica of those of the Instituto Finsen at Copenhagen. The radium department has 2 Gm. of radium. Patients of any of the municipal hospitals of the federal capital who need physical therapy should be treated at this new hospital, since the only radiologic services given by the other municipal hospitals will be those related to roentgen diagnosis. The personnel comprises 170 persons. Patients will pay in accordance with their economic condition. Only indigent persons or fathers of many children will receive free treatment. The fields covered by the new hospital will include roentgenography, radioscopy, radiotherapy, radium therapy, electrotherapy, electrodiagnosis, electrocardiography, artificial and natural phototherapy, kinesitherapy and hydrotherapy. Each department has enough subdepartments to cover the entire number of physical therapeutic methods hitherto known. The new hospital has excellent installations and it is well equipped. There are also special technical laboratories as well as laboratories of chemistry and bacteriology.—*Foreign Letters J. A. M. A.* **96**:2136 (June 20) 1931.

New X-Ray Method Reveals Sex Before Birth of Baby

Whether to trim the baby basket in pink or blue, always a vital problem to young married couples, can now be determined as early as three months before the birth of the expected child through the use of a new x-ray photographic method developed by Dr. Thomas O. Menees, of the Blodgett Memorial Hospital, Grand Rapids, Michigan, who exhibited his photographs to the American Association for the Advancement of Science in Cleveland.

This new method of ascertaining the sex of the unborn baby many weeks before birth is expected to relieve the anxiety of prospective parents who under present circumstances are impatient to know whether their offspring is a boy or girl.

No hope is held out that the new method developed by Dr. Menees, or any other known method, can be used to assure the mother giving birth to a child of the sex most desired by the parents. The sex of the child is determined at the very beginning of its pre-natal life and seems to be dependent upon chance.

Dr. Menees has made several successful diagnoses of sex of unborn babies. The method consists of injecting into the surroundings of the unborn baby a small amount of concentrated solution of strontium iodine. This practically harmless chemical has the property of being relatively opaque to the x-rays, and the fleshy parts of the baby as well as its tiny bones can be identified on the x-ray photograph. The effect of the injection fades after two or three hours and entirely disappears in a day. Dr. Menees calls the method "amniography."

More important to the physician and to the mother is the fact that amniography can be used to ascertain in doubtful cases whether a Cæsarian section will be necessary in order that the child may be safely born. It will probably be used much more frequently for this purpose than for ascertaining sex.—*Science News Letter* (January 31), 1931.

Study Shows Sunlight Increases Nutrition

Studies showing how sunlight increases the nutrition of the human body have just been reported to Science by W. W. Lepeschkin of the Desert Sanatorium and Institute of Research at Tucson, Ariz.

Mr. Lepeschkin studied the action of sunlight on red blood cells. When these cells are suspended in a salt solution and exposed to direct sunlight, they gradually disintegrate and are destroyed. Their resistance to poisons is very much reduced. Only the visible rays of the sunlight reduce this resistance, how-

ever. Ultraviolet rays, if they are weak or act for a short time, increase the resistance of the red cells and protect them against the harmful effect of visible rays, Mr. Lepeschkin found.

Visible rays of sunlight affect red blood cells in another way. Cells that have been exposed to this light are more permeable to water-soluble substances. Such irradiated corpuscles can take up increased quantities of sugar, the experiments showed.

"It may therefore be assumed that the nutrition of red cells is enhanced by sunlight," Mr. Lepeschkin concluded. "As the chemical and physical structure of red corpuscles is similar to that of colorless cells, the results obtained on red corpuscles can be extended to all cells of our organism, and it is likely that sunlight increases the nutrition of our organism in general."—*Science News,* May 30, 1931.

Viosterol Found Beneficial in Radium Poisoning

Almost simultaneously with the news of the twentieth death from radium poisoning among the unfortunate watch factory workers, comes the annoucement of a promising method of treating the condition. Viosterol, now often given children in place of cod liver oil to prevent or cure rickets, has benefited a number of victims of radium poisoning, Dr. Frederick B. Flinn of Columbia University, New York, has reported to the American Medical Association.

Because radium is related to calcium, it was supposed that any treatment that would affect calcium might have a similar action on the radium deposits, Dr. Flinn explained. So he first tried treatment with an extract of the parathyroid glands. These small glands, located behind the thyroid in the neck, are thought to regulate the calcium of the body.

Parathyroid treatment had been moderately successful, when Dr. Flinn suggested the use of viosterol. Vitamin D, calcium utilization in the body, bone formation and the parathyroid glands are all linked together, so viosterol, which is a potent source of vitamin D, was a logical selection.

The results of this treatment in eight cases have been good. In two cases, radium was completely eliminated from the body. In the other six the amount of radium was materially reduced.—*Science News Letter,* June 27, 1931.

Northwestern University offers two special physical therapy courses beginning September 14th. For physicians—an intensive four-week post graduate course in general physical therapy. For graduate nurses and graduates in physical education—an intensive four-week course in electrotherapy and radiation therapy technic. Address John S. Coulter, M.D., Department of P. T., N. W. University Medical School, 303 E. Chicago Avenue, Chicago.

Dr. J. S. Hibben of Pasadena, Cal., who recently underwent an operation, is reported making satisfactory progress.

Rumford Medal Awarded Dr. Karl T. Compton

President Karl T. Compton of the Massachusetts Institute of Technology has been awarded the Rumford medal by the American Academy of Arts and Sciences, Cambridge, in recognition of his researches upon electrons and light waves. The fund providing the medal was established in 1796 by Benjamin Thompson, native of Massachusetts, the physicist who later founded the Royal Institution of Great Britain and became Count Rumford of the Holy Roman Empire.—*Science News Letter,* June 6, 1931.

Electron Waves Will Reveal Structure of Crystals

Waves of electrons will soon allow the scientist to obtain a clearer picture of the internal structure of crystals than ever before possible, Dr. C. J. Davisson of the Bell Telephone Laboratories, New York, predicted to the American Association for the Advancement of Science and the American Physical Society in Pasadena.

Very short wavelengths are available in electron waves and this results in greater power to photograph the fine crystal structure of matter. Dr. Davisson is a pioneer in the use of electron waves since he won international fame a few years ago by proving that electrons acted like waves in much the same way as light and x-rays. He has also developed lenses for concentrating the beam of electrons. Since the electron may be termed a particle of electricity, his work bridges the previous gap between matter and electricity.

Just as shortening the wavelength of light used in illuminating a microscope allows smaller objects to be seen, use of electrons made visible by their effects on photographic plates allow physicists to study more minute structure in crystalline matter, Dr. Davisson explained. The electron waves are diffracted by crystals and give rise to diffraction patterns which are quite similar to those produced by x-rays. X-ray studies have given much information on matter's structure in the past decade.

The scattering power of atoms is about a million times greater for electron waves than for x-rays, Dr. Davisson explained. The electron waves will therefore give information chiefly regarding the structure of surfaces of crystals, whereas the x-rays give information about the structure of the bodies of crystals. He also expects that the electron waves will allow the study of layers of gas attached to the surfaces of metal crystals.—*Science News Letter,* June 27, 1931.

X-Rays Are Most Destructive To Young, Growing Cells

X-rays in sufficient doses are destructive to all kinds of living cells, but they are most destructive to cells that are physiologically young and active.

This is one of the basic physiological facts that underlie radiotherapy, Dr. Arthur U. Desjardins of the Mayo Clinic told a meeting of the American Association for the Advancement of Science in Pasadena. It follows from this principle that tissues that remain "chronically young" respond to x-ray dosage much smaller than those needed for effect on maturer tissues.

The most sensitive of all the cells in the human body are certain classes of white blood corpuscles, and the glands and other tissue masses where these are found most thickly are also very sensitive to the destructive rays. Dr. Desjardines inclines to the opinion that the easy destructibility of these white blood cells is at the bottom of the value of x-ray therapy in certain inflammatory conditions. White blood corpuscles crowd around foci of infection, causing inflammation. The x-rays break them down, releasing the germ-destroying substances they have formed within themselves, and thereby hastening the death of the trouble-causing bacteria.

Certain kinds of tumors and cancers can be treated with x-rays because the cells constituting them are physiologically younger than the surrounding tissues. The diseased growths are therefore destroyed by doses of x-rays that do no appreciable harm to the healthy tissues.

The most sensitive of normal body tissues are the mucous surfaces lining the digestive and certain other cavities. Muscle, bone and nerve tissues are among the most resistant.—*Science News Letter,* June 27, 1931.

New Process Cheapens Ultraviolet Glass

Development of a completely automatic process of manufacturing window glass of high ultraviolet transparency has made possible the production of this glass in quantity at about one-fourth the cost under old methods. The new glass has been described by Donald E. Sharp, glass technologist.

The new process has been installed in a large commercial plant in which, during the first month of operation under the new system, approximately 200,000 square feet of ultraviolet transmitting glass were manufactured. Production for the remainder of the year is expected to reach nearly 2,000,000 square feet.

While methods of making ultraviolet transmitting glass have been known for years, Mr. Sharp explained, it has been possible to make glass for workable commercial quality only in relatively small amounts with much hand labor and at great cost. Although glass made under the new process still costs two or three times as much as ordinary glass, it is cheaper than plate glass and about 75 per cent less than it was six months ago.

Technical difficulties involving composition, crystallization, and annealing are overcome by the new process, Mr. Sharp stated. It was explained that a special variation of the Fourcault window glass system, which permits the drawing of large, continuous sheets, is used. As is generally known, this glass must be almost entirely free of iron.

"Up to the present, attempts to make ultraviolet transmitting glass in this country by automatic means have resulted only in the production of glasses which in ordinary thickness had an ultraviolet transmission of only two or three per cent for the ultraviolet wavelength known a 302 millimicrons. The new process produces a glass that will transmit

permanently through the standard thickness of about eight one-hundredths of an inch, more than 50 per cent of the ultraviolet light it receives from the sun." — *Science News Letter,* July 4, 1931.

X-Rays Made Without Using X-Ray Tube

X-rays have been produced by a new method which does not require the use of the usual x-ray tube, by M. G. Reboul of the Physics Laboratory, Montpellier, France. The x-rays are produced when electric currents are driven through solids of high electrical resistance with the help of high electrical pressures.

In materials that conduct the electric current badly, like the magnesia, alum and yellow oxide of mercury used in these experiments, most of the voltage used is taken up in driving the current across one end of the specimen. At this point where the large fall of voltage occurs, x-rays of low penetration are produced.

In order not to interfere with the emission of the radiation, the electrode at which this large fall of voltage occurs is given a grid form. The material used is in the form of rods, about three and a half inches long and an inch in diameter, surrounded by ebonite, and an arrangement is provided for pressing the electrodes against the ends of the rod by means of an ebonite screw.—*Science News Letter,* July 4, 1931.

Positive Facts About Cancer Summarized Before Surgeons

"Cancer is today a greater menace, a more formidable scourge, than any other malady threatening our national life, with the exceptions of crime and the drink habit," declared Dr. Howard A. Kelly of Baltimore during the meeting of the American College of Surgeons in Philadelphia.

"With all our efforts, experimentations and investigations, we are as yet far removed from any worth-while knowledge of the ultimate cause or causes of this dread enemy," he said. We do, however, know a few helpful things about it. First, we know it is not contagious. Second, like every other ill in life, it is most successfully treated in its earliest stages when it is a purely local affair. Finally, we know certain preventive measures which can be taken.

"The golden rule of prevention is to look upon every persistent sore or lump in the skin, breast, mouth or any accessible part of the body as potentially serious until a competent doctor or surgeon declares otherwise," Dr. Kelly said. Any unusual condition should be investigated at once. Delay is dangerous, he emphasized. The sad habit of watching lumps or lesions until their nature becomes obvious and both doctor and patient are at length persuaded that something ought to be done is responsible for the loss of many precious lives."—*Science News Letter,* January 24, 1931.

Government to Check Vitamin Food Claims

Buyers of food have become so vitamin-conscious, that an expenditure of over $30,000 by the Food and Drug Administration will be required next year to check up on foods advertised as containing these important substances.

In presenting to the House Committee on Appropriations the necessity for the vitamin work, the Food, Drug and Insecticide Administration pointed out that to take action in cases where false claims were made for vitamin potency, it would be necessary to have scientific tests made, for which work the bureau is not equipped at present.

It is believed that the public is being cheated of vast sums of money through being induced to purchase foods falsely advertised as rich in one or more of the essential vitamins.

The agricultural appropriation bill, passed by the House and now before the Senate, carries an item of $30,200, for the vitamin testing work by the U. S. Department of Agriculture.—*Science News Letter,* January 24, 1931.

Prof. Linus Pauling to Be Honored

Award of the A. C. Langmuir prize for chemical research to Prof. Linus Pauling of the California Institute of Technology was announced today by the American Chemical Society. The prize of $1,000 will be given Prof. Pauling at the 82d meeting of the society in Buffalo on Sept 2. Pauling is only 30 years of age.

THE STUDENT'S LIBRARY

BOOK REVIEWS

TEXT BOOK OF PHYSICAL THERAPY. By *William Benham Snow,* M.D. Pp. 708, illustrated with 183 text cuts. Price $10.00. New York: Scientific Authors' Publishing Company, 1931.

This book is in many respects an extraordinary document. It is the posthumous work of a man who rose above physical handicaps to leadership in his chosen specialty in America. It is distinctly autobiographical in character for it embodies some three decades of active labor in the service of physical therapy. The present volume deals with the clinical nature and action of the constant and static current, high frequency currents, both medical and surgical.

In spite of the voluminous nature of the text there is hardly anything in its pages that has not been said by others and probably with equal facility. In that sense it is difficult to understand wherein the author has fulfilled his objective in contributing "a more specific outline of methods, indications and dosage of the various physical measures to give a better working basis for the student or physician unfamiliar with the subject". The affirmations of the author are couched in that enthusiastic, trenchant style reminiscent of *ante bellum* publications. The literary quality of the book makes delightful reading for it is rich in facile expressions and reflects the mature style of seasoned writing. As such, it probably offers the best cross-section of the evolutionary history of physical therapy in America that has yet been written. Its autobiographical implications are an interesting byproduct in the development of the author's thesis, and probably will have greater value to future students of the subject than its major premise.

There is much in these pages that recalls the quixotic nature of the man. His polemic attempt to establish Morton as the discoverer of high frequency current is about as pathetic as fighting windmills. His loyalty and affection for Morton, his teacher, has unconsciously made him twist the existing facts in a manner that does poor credit to our understanding of true sportsmanship. In spite of all that the author has inferred, Hertz and d'Arsonval and Tesla have honestly and independently earned their laurels in the field of science. Diligent search of the reviewer has failed to elicit any mention in the published work of these scientists regarding their obligation to Morton for their renowned discoveries. A great deal of this type of specious writing is to be found scattered in the text, much to the detriment of some very fine contributions of a clinical nature.

The author attains praiseworthy heights in his clinical discussion of the various "modalities" utilized in the practice of physical therapy. Practically the entire gamut of "modalities" is considered in the present work. Striking success has been achieved by the author and his many disciples in a host of conditions that are usually listed among the failures of medicinal therapy. The explanations are frequently naïve and beyond physiopathological interpretation, but no matter how doubtful the interpretation of the action of these "modalities", the favorable clinical results attained is the best recommendation for their use.

Although we are of the opinion that other existing publications would serve a better purpose for the beginner of this discipline, we feel that this work is a valuable addition to the library of all practitioners already oriented in the subject. It is rich in clinical exposition and seasoned experience, and because of this it is highly recommended to the profession.

HANDBUCH DER KINDERTUBERKULOSE. (Two volumes.) By *Prof. Dr. St. Engel* (Dortmund) und *Prof. Dr. C. Pirquet* (Wien). Pp. 1591 and highly illustrated with engravings and charts. Paper. Price 64 R.M. Leipzig: Georg Thieme. 1930.

This handbook, encyclopedic in its material and size, is a monument to Clement Pirquet, for it was the advent of the dermal tuberculin reaction by Pirquet which stimulated the vast studies in childhood tuberculosis.

These two volumes contain monographs by a group of the most celebrated students in the world on that disease. Edited by Engel of Dortmund and the late revered Pirquet of Vienna, the fifteen hundred and ninety-one pages represent contributions from such eminent authorities as Stanley Griffith, Anton Ghon, Bruno Lange, Hermann Beitzke, Franz Hamburger, Markus Hajek, Rudolph Fischl, Hans Kleinschmidt, Arvid Wallgren, Ernest Moro, Franz von Gröer, Bela Schick, and Theodor Fröhlich. To those interested in physical therapy, the chapters by Oscar Bernhard on the climatic treatment of extra-pulmonary tuberculosis will be found most valuable. Bernhard, one of the great pioneers in heliotherapy, presents a most interesting dissertation on the value of air exposure, heliotherapy, technique of the sun cure, and the details involved in the treatment of the various extrapulmonary tuberculous conditions, such as tuberculosis of the skin, the serous membranes, lymphatic, bones and joints, genital organs, renal, eye, ear, nose and throat, peritoneum, pleura, etc. E. Mayerhofer and M. Sarcevic have also contributed a most excellent chapter with a group of fine illustrations depicting the use of sea bathing in the treatment of tuberculosis of the bone and joints. The patients, strapped to their Bradford

frames or other orthopedic appliances, are immersed in the water of the sea. This procedure is an adjunct to the operative and heliotherapy. The other chapters on infection, pathogenesis, epidemology, pathology, prognosis, and the various clinical manifestations of tuberculosis in childhood are encyclopedic in extent, and the authenticity is guaranteed in the names of the contributing authors.

Every student of this disease should not fail to add to his library so important a publication. I feel it would not be amiss to mention the excellence of the publisher's art that has gone into the development of this wonderful publication.

PRACTICAL DIETETICS FOR ADULTS AND CHILDREN IN HEALTH AND DISEASE. By *Sanford Blum,* A.B., M.S., M.D., Head of Department of Pediatrics and Director of the Research Laboratory San Francisco Polyclinic and Post-Graduate School. Fourth revised and enlarged edition. 380 pp., $4.00. Cloth. F. A. Davis Company, Philadelphia, Pa. 1931.

The place of the diet in the field of medicine plays an important part not only in the correct treatment of different ailments, but in maintaining one's good health. The volume here reviewed is divided into two parts, Dietary for Adults in Health and Disease and Dietary for Infants and Children in Health and Disease.

In striving for clearness and simplicity which is the aim of the author it seems as if much has been omitted. The book abruptly opens with a discussion of "Acidosis", and all diseases are discussed thereafter in alphabetical order as to what "to eat" and what "to avoid". This method of presentation, consequently, involves repetition.

Some of the newer ideas of diet in disease have not been incorporated. For example, in the discussion on Acute and Chronic Nephritis, the old idea of using meat sparingly is advocated without cognizance of the fact that milk and eggs are permitted freely, two foods with a high protein value. No mention is made that if meat is taken, eggs should be spared. Eggs are recommended as a choice at every meal. In listing vegetables, the patient is free to choose "any" as a salad. No precaution is sounded, for example, as to avoiding cucumbers, tomatoes or asparagus.

The popular treatment of epilepsy and migraine by a high fat and a low fluid intake is not mentioned. It is disappointing to find no reference as to amounts of food quantities or numbers of calories. Much space is devoted to the subject of infant and child feeding, a very necessary knowledge and one which is welcomed by the general practitioner.

The author is to be commended in calling our attention in a forcible way to preserving our health. Just how one is to arrive at this successfully is to be questioned inasmuch as no discussion is to be found of fundamental food principles, and the consequent knowledge of a balanced diet. The book is to be recommended if a none too critical work on diets is desired as it represents a painstaking accumulation of the experience of one who has spent much time prescribing these diets under given conditions.

PHOTOBIOLOGIE: Fundamentals — Results — Outlook. By *Ludwig Pincussen.* Dr. Med. et Phil. Director Der Biolog.-Chemischen Abteilung Am Stadt. Krankenhaus Am Urban Zu Berlin. Pp. 543 with 101 illustrations. Price, paper, 36.M.; bound, 39.M. Leipzig: Georg Thieme, 1930.

This book is one of the finest examples of scholarly exposition on the general and specific action of light radiation that has come to our attention in recent years. In its pages are incorporated one of the most substantial surveys and interpretation of the basic facts regarding the action and future outlook of photo-radiation that has been gathered together in any single volume. Every page, every chapter, is solidly crammed with important facts — facts of interest to the physicist, chemist, biologist and physician. The many references introduced as footnotes offer some very fine collateral reading for the student who is especially interested in any phase of the subject.

The work is divided into two sections. The first part deals with the physical nature of radiation; that is to say, its laws, color and absorption, fluoresence and light sources; measurements, chemical action of light; isomerization, polymerization, oxidation and reduction, photo-synthesis and other reactions. Nearly one-half of the volume is devoted to the consideration of the physical and photochemical action of photo-radiation.

The second division discusses the action of these rays of biologic structure. Fifteen chapters of solid exposition have been devoted to this section. The material throughout the book is thoroughly checked by mathematical data, formulae and tables. From this point of view it may be presumed that the book will probably be read with greater appreciation by those more mathematically inclined. It should, however, be pointed out that in spite of its mathematical background, this book is probably one of the richest sources of information on the action of ultraviolet radiation in connection with living material that has been published in any language. The serious minded student of the subject, be he physicist, chemist or physician, will welcome Dr. Pincussen's labors as a rare contribution. The publishers are to be commended for the fine cooperation devoted to the physical makeup of the book. The clear type, the illustrations and the exact reproduction of complicated formulae are indications of the painstaking labor that entered into the construction of the book. The book is highly recommended to the profession and to students of photobiology.

ORTHOPAEDIC SURGERY. By *Royal Whitman,* M.D., M.R.C.S., (Eng.), F.A.C.S. Pp. 1085 with 981 engravings. Cloth $10.00 net. Philadelphia: Lea & Febiger, 1930.

The ninth edition of Whitman's book represents the most conservative and detailed exposition on orthopaedic surgery produced in America. Each edition has anticipated the newer tendencies and kept pace with conservative innovations and special progress. The present volume therefore embodies

the most representative opinions on the subject. Each chapter is monographic in character and exhaustive in quality. By this is meant that each subject has been brought down to date, elaborated in proportion to its importance and rounded out in a manner both satisfactory to the specialist and comprehensive to the general practitioner. The text is generously illustrated with splendid engravings thus greatly enhancing the value of the exposition. One cannot refrain from complimenting the publishers for the clear type and pleasing makeup of the book, facts, readily sensed by the average reader but seldom given expression. We cannot refrain from once again stating that this book is probably the most authoritative and comprehensive contribution in orthopaedic surgery in the American language. It should especially appeal to the industrial surgeon and specialist in physical therapy because of their allied interest in the subjects which are so comprehensively discussed in this book. The book is highly recommended to the profession.

MAN AND THE STARS. By *Harlan True Stetson*. Director of the Perkins Observatory, Ohio Wesleyan University. Pp. 221, with 56 half-tones and illustrations; $3.00, Cloth. Whittlesey House (McGraw Hill Book Company) New York, 1930.

This work is an informal treatise on astronomy, presented in four parts, each part consisting of from three to six chapters. The author's foreword is especially worth reading as it at once introduces the reader to the style, the aim and the ability of the author to present a difficult subject in a popular and fascinating manner. He tells us he is not offering a text book, although various chapters do incorporate material given in certain academic lectures as well as the author's views on certain popular questions which have confronted him in these lectures.

The human touch which the writer's style gives to the presentation of the contributions of such men as Huyghens, Herschel, and Newton is particularly noted. As the author states, while not intending biographical sketches, he does want to portray what he calls "the romance of science." There is always something impressive about the expression of a scientist, one who has spent much of his time and energy on the abstract. His work, when we read it, seems to be free from the entanglements of human nature, which, to the reader is indeed relaxing. The author puts us continually at our ease in the study of the physical sciences. For example, in explaining Doppler's law he cites in way of explanation that the sound of a country church bell as we drive towards it has the sound of a rising pitch, "as if in happy anticipation of a small increment in the congregation as the result of the approaching car." Likewise, a sudden drop in the sound and a corresponding drop in interest occurs as we drive away from the bell.

Many similar examples could be given which prove the author's ability in reducing his subject to simple and understandable language. He finally leaves us with the thought that the mind is the only persisting reality. This book is to be recommended to those who have their minds so "keyed-up" to responsibilities, that their manner of recreation cannot consist in a complete "let-down" but a transfer of interest which should also be stimulating.

INTERNATIONAL ABSTRACTS

The Influence of X-Ray Lesions of the Intestinal Mucosa on Absorption of Glucose and Other Sugars. K. W. Buchwald.

J. Exper. Med., **53**:*827 (June) 1931.*

A sublethal dose of x-rays was applied over the abdomen of rats and over the thorax for control purposes. 20 and 40 hours after radiation *(i.e.* during the "latent period") the rate of absorption of glucose, fructose and mannose was markedly diminished. Simultaneously definite histological changes were observed in the intestinal mucosa. In spite of the decrease in the absolute amount absorbed, the relative rate of absorption of the three sugars mentioned remained nearly unchanged, indicating that the epithelial cells retained their selective action on sugars.

The Symptomatology and Treatment of Alcoholic Peripheral Polyneuritis. Albert T. Steegmann.

The Physiother. Rev., **11**:*2 (Jan.-Feb.) 1931.*

The aim in the treatment of alcoholic peripheral polyneuritis may be approached from several viewpoints. First, supportive treatment during the period of nerve destruction and regeneration. Second, the prevention of contractures which may produce severe deformity if allowed to develop. Third, establishing proper rapport with the patient's mental attitude.

Absolute abstinence from alcohol is the first essential of treatment. The physiology of sensation is useful in determining the type of supportive treatment to be given at various stages. During the acute, painful stage continuous dry heat should be given by means of a light cradle or heat lamp. The extremities should be wrapped in cotton and supported in such a way as to prevent contractures. That means a right angle splint for the feet and cock-up splint for the hands. To prevent contractures at the knees an extension on the splint of a few pounds of weight is necessary. Gentle stroking and kneading of the muscles may be begun as soon as they are no longer painful. Active massage and the galvanic current may be started when all pain and tenderness have disappeared. As soon as the wrists can be manipulated the cock-up splints should be removed and the wrists supported on the extensor surfaces by means of an elastic extensor support fastened to gloves, thereby giving extensor muscle action, temporarily.

The prognosis is usually good, but the condition runs a course of from seven months to two years. Recovery in the legs may not be entirely complete but it is in the arms, as a rule.

Recurrences are frequent if alcohol is again used. The nerve fibers, when once damaged, are more susceptible to the same toxic agent.

In treating the neuritides, because the progress is slow, the patient in the average hospital where extensive physiotherapy can be used may become quite discouraged. He appreciates "laying on of the hands." It helps to keep up his morale. We must remember that "the patient has the disease as well as the disease has the patient." The physiotherapist by her contact with the patient can not only apply scientific procedures but can also do a great deal to encourage and interest the patient during the long process of nerve regeneration with its subsequent return of function.

Roentgen Studies on Etiology of Urethral Incontinence. F. von Mikulicz-Radecki.

Zentr. für Gyn., **55**:*795 (March 14) 1931.*

In his roentgen investigations on the etiology of urethral incontinence, von Mikulicz-Radecki made side exposures of the patients while standing, and also when they were reclining. He describes the technic of the examinations which he performed on thirty-five women. Twenty-three of these had urethral incontinence, whereas the other twelve were normal and served as controls. If innervation disturbances of the sphincter are disregarded, there are three factors which might cause urethral incontinence; namely (1) direct injury of the muscles of the sphincter (tearing, scars and atony), (2) descent of the connective tissue supporting the trigonal section of the sphincter, and (3) injury of the sphincter attachment in the urogenital diaphragm. All these factors are mainly caused by obstetric injuries, and in many cases of incontinence all three factors are involved.—Ab. *J. A. M. A.*, **96**:2170 (June 20) 1931.

Treatment of Pernicious Anemia by Ultraviolet Rays. D. I. Macht.

Brit. Jour. Act. and Phys., **5**:*228 (February) 1931.*

The author found that the blood in pernicious anemia patients was markedly toxic for *Lupinus albus* seedlings, while the blood of patients with other types of anemia did not show this peculiar toxicity. Further experiments showed that irradiation of pernicious anemia blood in quartz containers with ultraviolet rays markedly reduced this toxicity; this detoxifying action of the ultraviolet rays could be increased by the addition of a sensitizer in minute quantities to the blood; the most active sensitizer was found to be the sodium salt of tetra-brom-fluorescein or chemically pure eosin. In view of these findings a number of patients with pernicious anemia have been treated by various clinicians with general ultraviolet irradiation,

using either a mercury vapor or carbon arc lamp; and the blood tested for toxicity by the author's method at intervals. Some of these patients were also given eosin in doses of about 40 mg. intravenously ten to fifteen minutes before light treatments. In these cases, the patients showed a very definite improvement in both subjective and objective symptoms; the blood count returned nearly to normal, and the color index was reduced. At the same time the toxicity of the blood as tested by the author's phytopharmacological method was markedly decreased or disappeared entirely. No other form of treatment has so marked an effect on the toxicity of the blood serum. In some cases of pernicious anemia that did not respond well to liver treatment, the toxicity of the blood has been found to be high; ultra-violet irradiation and eosin, in these cases, not only reduced the toxicity of the blood, but also resulted in marked clinical and hematological improvement. The most efficient wave lengths have been found to be between 3130 and 2967 A. U.—Ab. *M. T and L. I. M. J.*, **59:***224 (June) 1931.*

Roentgen Irradiation Treatment of Insomnia. H. Uiberall.

Med. Klin. **27:***465 (March 27) 1931.*

Before reporting the results of his attempt to influence certain forms of agrypnia by roentgen irradiation of the basal portions of the brain, Uiberall discusses the types of agrypnia. He differentiates between the primary and secondary forms. The primary form is due to a disturbance in the sleeping mechanism of the brain, whereas in secondary agrypnia the cause lies outside the sleeping mechanism, in psychic factors, pain or external irritants. Roentgen therapy is successful only in the primary cases. Primary agrypnia may result from encephalitic processes, from toxic injuries of the sleep center in the course of generalized diseases, from hormonal disorders or from fixation of formerly existing secondary agrypnia. The author's method of treatment was roentgen irradiation of both temples and of the center of the forehead in order to reach the hypophysis. The single dose was about one-third of the unit skin dose, which was varied in individual cases. It was applied through a filter of 0.5 mm. of zinc, with 170 kilovolts, at 30 cm. focus distance, and on a field measuring 6 by 6 cm. The three fields were irradiated at intervals of from two to four days. If necessary, a second series was applied from three to four weeks later. Among thirty patients treated in this manner there were nine patients with secondary agrypnia, and in none of these was the treatment effective. Of the twenty-one patients with primary agrypnia, ten were cured completely by the roentgen irradiations, four showed improvement, in three others the effect was uncertain and in four patients there was no effect whatever. From these results the author concludes that roentgen irradiation of the basal portions of the brain is a promising method for the treatment of primary insomnia.—Ab. *J. A. M. A.*, **96:**2169 (June 20) 1931.

Effect of Exposure to Ultrahigh Frequency Field on Growth and Reproduction in White Rat. A. Knudson and P. J. Schaible.

Arch. Path., **11:***723 (May) 1931.*

The authors assert that, since the development of a high frequency oscillator for the production of artificial fever in man, it has become of increasing importance to know the biologic reactions produced by such an agent. They accordingly planned an investigation to determine the effect of exposure to a high frequency field on growth and reproduction in the white rat. It was found that exposure of young rats to an ultrahigh frequency field for periods of from one-half to one hour daily and raising their body temperature to 40.5 C. (104.9 F.) does not seem to retard their growth appreciably. The reproductive organs in the male and female rats are not appreciably affected, so that there is no loss in power to breed. Repeated exposure of rats to an ultrahigh frequency field in which the body temperature is raised to 40.5 C. does not produce any abnormal pathologic lesions.—Abs. *J. A. M. A.*, **97:**349 (Aug. 1) 1931.

Physiologic and Biochemical Changes Resulting from Exposure to an Ultrahigh Frequency Field. A. Knudson and P. J. Schaible.

Arch. Path., **11:***728 (May) 1931.*

According to Knudson and Schaible, the body temperature of dogs can be raised to any desired point by exposure to an ultrahigh frequency field. The temperature returns to normal quite rapidly unless the animal has been heated above 42 C. (107.6 F.). Animals heated above 42.5 C. (108.5 F.) for any great length of time do not survive treatment. Exposure of animals to an ultrahigh frequency field results in loss of weight, which is dependent somewhat on the length and intensity of treatment. There is also a decrease in blood volume amounting in some experiments to as much as 25 per cent. The concentration of the blood was also evidenced by the increase in cell volume and hemoglobin. Weight and blood volume usually return to normal within twenty-four hours. Raising the temperature of animals to 41.7 C. (107 F.) does not produce any great change in hydrogen ion content of the plasma, although there is a tendency toward a condition of alkalosis. With higher temperatures, the tendency is toward a condition of acidosis, apparently caused by great increase in the production of lactic acid. The increase in lactic acid is probably due to greatly increased tissue metabolism resulting in a tissue anoxemia. Changes in the chloride, total protein and total base are accounted for by the dehydration. Bicarbonate was greatly reduced, owing to excessive pulmonary ventilation with rise in body temperature. Changes in the inorganic phosphorus were somewhat variable, although with a maximum temperature to 41.7 C. there is a marked reduction. Nonprotein nitrogen of the blood is generally increased; in some instances the increase is over 200 per cent. Urea nitrogen, creatinine and amino-acid nitrogen are also increased. These increases are accounted for

by the increased metabolism resulting from rise in temperature and by the oliguria. The blood sugar content in most of the experiments shows an increase, in some cases amounting to as high as 150 per cent. The greatest increase in blood sugar occurs in those experiments in which the *p*H has been lowered the most. There is an increase in both the red blood cells and the total white cells. Besides the increase in red cells there is in many instances a marked increase in immature forms of red cells, suggesting a stimulation of the hematopoietic tissues.—Abs. *J. A. M. A.*, **97**:350 (Aug. 1) 1931.

Morphologic Changes in Animal Tissues Due to Healing by Ultrahigh Frequency Oscillators. V. C. Jacobsen and K. Hosoi.

Arch. Path., **11**:*744 (May) 1931.*

Jacobsen and Hosoi describe the effects on animal tissues of exposure in the electrostatic field of a high frequency oscillator. Twenty-three dogs, twenty-seven adult white rats and three guinea-pigs were used in the experiment. A marked hyperthermia was produced in the animals, the amount of temperature increase being controllable by altering either the voltage or the distance between the plate electrodes of the apparatus. The morphologic changes occurring in the tissues were congestion of the organs, peripheral hyperemia, cloudy swelling, fatty degeneration, dehydration, glycogen depletion, focal hemorrhages, especially in the gastrointestinal tract, epithelial hyperplasia in the parenchymatous organs and stimulation of the bone marrow. Following prolonged periods of heating, degenerative lesions occurred in the male germinal epithelium. From a morphologic point of view the alterations observed differ but little from the effects of fever produced by various other methods, but the ease with which the temperature can be controlled in the high frequency field of this apparatus and the character of some of the tissue responses suggest possible therapeutic applications.—Abs. *J. A. M. A.*, **97**:350 (Aug. 1) 1931.

Birthmarks and Hemangiomas of the Oral Cavity. D. Y. Keith, M.D.

The Radiological Review, **53**:*3 (March) 1931.*

Small repeated applications of radium properly filtered will cure most of the thin superficial birth marks on the skin or in the oral cavity. Where massive tumors are present, or when nodular rapidly growing tumors appear at the site of a birth mark or in an haemangioma, radium emanation implanted into the center of the mass or masses will give quicker and more pleasing results. Lesions of the mucous membrane will frequently give brilliant results as are seen in lesions of the skin with little or no scarring. These defects are much more sensitive and better cosmetic results can be obtained in infancy and early childhood with much less treatment than when they are allowed to remain until adult life is reached. More vigorous treatment is necessary if the lesion is rapidly increasing in size.

Ueber Die Anwendung Der Elektrischen Gleichstromtherapie In Der Chirurgie. (On the application of electrical direct current therapy in surgery). Heinrich Heusser.

Schweiz. med. Woch. 1929. **59**:*9 (March) p. 250-252.*

Electroendosmosis plays the essential part in galvano-therapy. For the introduction of electrolytes, the efficient ion of which is the cation, the following claims must be raised: first, introduction by anode; second, the solution to be introduced should be as good a conductor as possible, which can be attained by strong dilution, solution in alcohol or sugar solution; third, the applied solution should not contain acids nor polyvalent cations. Regarding the introduction of anions it is to be noted: first, introduction by cathode; second, the concentration of the solution should be higher and acidified; third, polyvalent cations are to be used.

The technical performance of the continuous current therapy is simple. The corresponding requisites are a pantostat with milliampere-meter, a number of electrodes of various size of lead or zinc sheet for the indifferent pole, and a cuff as an indifferent electrode. The amperage in use commonly amounts to 0.5 MA. per square cm., according to the size of the electrodes from 10 to 50 to 100 MA. The current should be switched on slowly; time of one sitting amounts to from 10 to 30 minutes. The sittings can be repeated every second or third day according to the condition of the skin. As for medicaments, the author's experiences refer to copper, cocain, iodine and salicyl. The two first mentioned substances are to be introduced by the anode, consequently from the positive pole, being cations, while for the anions, iodine and salicyl, the negative pole is to be taken as active electrode.

According to the author's experiences the introduction of 1 per cent copper sulphate solutions is very beneficial in the treatment of fresh, evolving furuncles. Skin scars and keloid are softened after cataphoresis and favorably influenced by iodine from the cathode. In contractures of joints of the fingers and wrist, electrophoresis with iodine solutions as well as with salicylated solutions yielded good results. The author also obtained satisfactory and quick effects in cases of sciatica, in which painful procedure could be avoided by the application of salicyl by way of galvano-therapy. Noteworthy results were also obtained in trigeminal neuralgia.

Bronchogenic Carcinoma. A Pathological Study of Sixteen Instances. Frank R. Menne, M.D., F.A.C.P., Marr Bisaillon, M.D., F.A.C.P., and Thomas D. Robertson, M.D.

Northwest Medicine, **30**:*4 (April) 1931.*

1. A study of sixteen instances of primary bronchogenic carcinoma with a correlation of the pathologic and clinical findings is presented.

2. Primary bronchogenic carcinomas are divisible into two distinctive groups, the hilar nodular and the diffuse necrotic. Further pathologic classification is superfluous and unnecessary.

3. It is pointed out that the cell type does not

offer an exact means of differentiating the various forms of primary bronchogenic carcinoma.

4. The initial site of primary bronchogenic carcinoma may be found in any part of the bronchial lining or the submucous glands, but is most frequent in the primary and secondary bronchi.

5. Primary bronchogenic carcinoma probably never arises from the atrial lining cells.

6. The symptomatology, physical signs and roentgenologic findings can all be explained on the basis of the pathologic changes.

7. In our opinion there is a definite increase in the incidence of primary bronchogenic carcinoma.

Rational Therapy in "Rheumatism". Edward A. Rich.

The Physiother. Rev., **11**:*10 (Jan.-Feb.) 1931.*

To use vaccine and medical treatment alone is not enough. Joints are sore, swollen and contracted. Local treatment is of vital importance because it makes use of certain physiotherapy measures such as heat and massage. After years of experience we cling to hydrotherapy—Hot brine packs, hot towels, hot glucose baths, and colonic lavage. In our "Rheumatic Center" we have perfected the use of large heated tanks of glucose with the fluids ranging over one hundred degrees according to the condition. Glucose is easily kept sterile, holds the heat a long time, has osmotic powers, contains an astringent that hastily dries oozing, perspiring skin, and affords a vehicle of supplying heat easily borne at high temperatures. Glucose is a solvent, and when immersed, joints respond gratefully to massage. We believe that glucose is one of the best means of applying the needed hydrotherapy.

Nothing need be said further regarding the massage that follows heat immersion. We all know the value of soft, stroking, long continued manipulation and its effect on reducing joint swelling, in toning up atrophied muscles, and in relieving soreness. It is needless to add, when talking to trained therapists, that the overuse of massage by too long or too rough manipulation is a damning procedure, increasing muscular fatigue and damaging already terribly sore joints.

Combined vaccine, constitutional orthopedic and physiotherapeutical treatment now offers cure to 80 per cent of our chronic arthritics who have not progressed into the state of gross joint deformity.

Scoliosis. A Steindler.

The Physiother. Rev., **11**:*7 (Jan.-Feb.) 1931.*

The outlook in treatment of scoliosis is more hopeful today because of closer correlation between morphological and functional aims. No special or single standard of treatment can be applied to all. On the contrary there exists at present several methods which embody certain range of indications. They are: (1) the compensation method, (2) the forcible correction combined method, (3) the spine fusion method. (Hibbs, Albee). The author believes that any of these methods are of value in special instances and the choice of selection of method rests with the experiences of the orthopedic surgeon. No particular method is suitable in all instances.

Treatment of Arthrosis. F. Coste, J. Forestier and J. Lacapère.

Presse Medicale, **39**:*715 (May 16) 1931.*

Coste and his associates state that to outline the treatment of arthrosis it is only necessary to recall its pathogenic factors and its principal lesions. Among them they enumerate: (*a*) circulatory factors (arteriosclerosis, disorders of venous circulation), endocrine factors (especially ovaries), humoral factors (autointoxication or heterointoxication, sometimes gouty diathesis), limitation if not absence of inflammatory processes, and degenerative or dystrophic nature of the lesions; (*b*) importance of local mechanical factors (accidental or habitual static traumatisms) and local disorders of a circulatory, nervous or trophic nature; and (*c*) hypertrophic lesions, osteophytic, primarily osteocartilaginous and very little synovial, which wear away and destroy the centers of the cartilage. Under general medical treatment the authors include vaccines, protein therapy and phlogotherapy. They do not advise intravenous injections of colloidal substances. They recommend the use of chemotherapy, emphasizing the fact, however, that gold preparations are inactive. In the local treatment, they advise intra-articular injections of various lubricating substances. Para-articular proliferations may be influenced directly by local injections of various substances, such as iodized poppyseed oil or mixtures with camphor or benzyl salicylate as the base. For disorders of a mechanical origin the authors advocate the surgical and orthopedic correction. Among the measures of physical therapy, they outline vasodilator and calorific procedures for the activation and the modification of the local circulation; hot baths, various heating apparatus, infra-red rays, actinotherapy, heliotherapy and diathermy; also radiotherapy, ionization of the lesions of arthrosis, massage and immobilization.—Abs. *J. A. M. A.*, **97**:357 (Aug. 1) 1931.

The Prostate in General Practice. Ignatius J. Murphy, B.S., M.D.

The Radiological Review, **53**:*3 (March) 1931.*

There pass into the average physician's office daily many early cases of prostatic obstruction. The alert family physician is finding these cases and is asking for a fresh sample of urine for microscopic study, regardless of whether the man comes complaining of something else or merely accompanies another patient.

Beginning prostatic obstruction can usually be entirely relieved by palliative measures. Radium and x-ray give very definite results in selected cases of both benign and malignant obstruction.

The diagnosis and the treatment of the late cases with all the complications have been worked up in elaborate scientific detail. Educational propaganda for unearthing the early case by life insurance companies and by health agencies have not kept pace with either that of cancer or tuberculosis.

Penetration of Light Through Human Skin. A. Bachem and C. I. Reed.

Am. Jour. Physiol., **97**:*86 (April) 1931.*

Bachem and Reed state that visible and near infra-red rays are strongly absorbed by the blood of the corium and subcutaneous layers, with direct effects on the blood to be expected. The heating effect must be rather mild on account of the small absorption in the epidermis and the strong convection by the blood stream. The far infra-red has little penetrating power. Most of it is absorbed in the epidermis. The heat produced is slowly conducted away by the blood stream and by the air. Overexposure of the germinal layer may lead directly to blistering. There is greater variation in percentage penetration of ultraviolet than in other parts of the spectrum. At 280 millimicrons the absorption in the corneum and prickle-cell layers is pronounced. The great antirachitic effect of this wavelength must occur in or about these layers. On both sides of this band, near 300 and 250 millimicrons, the penetration is greater, more radiation reaching the stratum malpighii and the corium. These observations indicate that erythema production occurs in the germinal layer (or the corium) under the shadow of the upper layers. The stratum corneum and granulosum must play an important part in the light protection of these sensitive layers. From 250 millimicrons down the absorption in the horny layer increases rapidly. Near 200 millimicrons the absorption is so complete as to prevent any radiation from reaching the living layers of the skin. —Ab. *J. A. M. A.* (June 20) 1931.

Radiotherapy for Inflammatory Conditions. Arthur U. Desjardins.

J. A. M. A. **96**:*401 (Feb. 7) 1931.*

Among the conditions in which x-rays are of distinct value are furuncle, carbuncle, abscesses of soft tissue, peridental infection, acute adenitis, onychia, paronychia and erysipelas. In all of these, small doses are preferred; only one or two treatments are necessary, and the x-rays are applied to a zone which includes normal tissues well around the lesion. The dose should be from one-tenth to one-half the erythema dose. Desjardins assumes that the infiltrating cells, leukocytes and lymphocytes contain or elaborate within themselves the protective substances or other means which enable them to destroy or neutralize the bacterial or other toxic products that give rise to the defensive inflammation. Irradiation by destroying the infiltrating lymphocytes causes a liberation of the protective substances and makes them even more readily available for defensive purposes than they were in the intact cells. He cites the following evidence: The rapidity with which irradiated inflammatory lesions recede corresponds to the rate at which normal lymphocytes are known to be influenced by x-rays, and a small dose of irradiation is sufficient to procure the desired effect. Also, roentgen therapy is most beneficial during the infiltrative stage of the inflammatory process. In his experience roentgentherapy has been without effect in a relatively few cases, but there has never been an unfavorable action. The patients who have been benefited have been given a small or moderate dose of x-rays. The literature is critically analyzed and a full bibliography is appended.—Abs. *Archives Derm. & Syph.*, 23:4:736 (April) 1931.

Influence of Natural and Artificial Light on Basal Metabolism in Human Beings. G. Arnautov and E. Weller.

Zeitschr. f. d. ges. Exper. Med., **76**:*694 (May 16) 1931.*

Arnautov and Weller found that the basal metabolism of human beings is higher when the person is under the influence of either natural or artificial light than when the person is in the dark. Pulmonary ventilation is likewise greater under the influence of light. The authors emphasize that all the other factors that influence the basal metabolism were considered, so that, although the increase is slight, it cannot be doubted that it is actually caused by the influence of light.—Abs. *J. A. M. A.*, **97**:361 (Aug. 1) 1931.

Zur Behandlung Des Klimakterischen Ohrensausens. (On treatment of climacteric tinnitus aurium). Ernest Friedländer and Ignaz Sommer.

Monatsschr. f. Ohrenhlkde u. Laryngo-Rhinol. 1929. **63**:*10. (Okt.) P. 1019.*

Patients suffering from "buzzing in the head" as a rule exhibit increased blood pressure and other phenomena or disturbances of the vasomotor system; climacteric women constitute the chief contingent. The authors desist from local treatment in such cases—unless it be absolutely indicated by a lesion of the middle ear or nose—and first attempt to produce improvement by medicinal means (masculine or feminine polyhormone, eventually at the same time Klimasan). In case of failure, patients are ordered to take a bath on alternate days, the water of which is from 27° R. cooled down to 24° R., while the patient is therein. Duration of the bath is about 10 minutes, then rubbing or still better, slight massage; on days without baths, the patients are given a whole pack. On two large woolen coverlets is laid a dry sheet and over it a wet one. Then the patient lies down and is then quickly wrapped up in the wet sheet (each inferior extremity separately, the other layers are finally quickly joined over the patient). In most of the patients treated in such a manner buzzing of the ears ceased in relatively short time as well as the sleeplessness which is related to it. Tinnitus aurium disappears quickest in those patients with climacteric affections, in which the functional test of the cochlear nerve shows little or no disorder.

Treatment of Verruca Plantaris by Electro-Coagulation. P. Coignearai.

Bull. de l'hop. Saint-Michel **2**:*369 (Nov.) 1930.*

The method used by the author consists in employing bipolar electrocoagulation under local anesthesia. The treatment does not prevent the patient from continuing his occupation.—Abs. *Arch. Derm. and Syph.*, **23**:4:739 (April) 1931.

Injury to a Joint with Intra-articular Infusion of Blood — Treatment. R. Wachenheimer, Karlsrube.

Medizinische Welt, No. **38,** *1930.*

The following treatment is recommended: The injured joint should be painted with ammonium sulpho-ichtohyolicum and dressed with a luke-warm solution of diluted alum. acet. twice daily. The injured joint should then be placed on a padded wooden splint or Cramer splint in a raised position. According to the severity of the injury, the bandage is left on for 2—3—6 or 10 days; as soon as it is left off treatment with Ambrine is started. Ambrine is a mixture of various paraffins with the resin of South American pine trees (obtainable from the Ambrine Agency, Dresden A. 1, Jahnstrasse 3). Ambrine is also on the market under the name of Hygeia-8; source of supply: Fritz Vitt, Chemist, Graslitz, Czechoslovakia. The oil is heated to about 158 to 176°, painted on the skin with a bristle paint brush and covered with a layer of cotton-wool which is again covered with hot Ambrine and another, thicker layer of cotton-wool applied. The dressing should be changed every 24 hours. Later a day's pause is made. The dressing should be fixed on by an elastic bandage. The patient may move about with the dressing on. Massage is not absolutely necessary; if carried out too soon, massage may produce embolism. On the days when the patient is free from treatment he should have hot salt baths. The results of this method of treatment are very satisfactory.—Abs. *Ars. Medici,* **11:**1:19 (Jan.) 1931.

Ulcers of the Skin after X-ray and Radium Irradiation. E. Brunner, Röntgen and Finsen Institute of the Lazarus Hospital, Warsaw.

Strahlentherapie, **36,** *1930.*

Recommendation of a mixture of oil and wax 1:6; which has an analgetic effect. Anaesthetic remedies may cauterize. 1 per cent Rivanol salve is also well tolerated. Otherwise Sollux lamp and quartz light irradiation are also recommended; the latter somewhat carefully locally, or better still as general irradiation uncovering the injured tissue, according to *Artz* and *Fuhs.* Local Finsen irradiation is also effective.

Municipal Hospital, Dortmund. P. Eichler.

Medizinische Welt, No. **43,** *1930.*

After x-ray irradiation all injuries or irritation of a chemical, mechanical, thermal or physical nature should be avoided. The following remedies are therefore prohibited: painting with iodine, iodine salves, sticking or adhesive plaster, ointments containing metal substances, or irritating ointments of any kind, desquamating pastes, Lysol, alcohol, benzine, Eau de Cologne, damp compresses or bandages, particularly with acetate of aluminum, UV-rays, diathermy, heated pad, hot water bottles, ice bags. Friction by clothes may not take place. In the morning and evening the skin is rubbed with a non-irritating salve. Such salves are either lard or the Raderma salve (Obermayer and Co., Hanau) or Kamillosan salve (Chem. Pharm. Stock Co., Bad Homburg). In case of pain no local anaesthetics. After the conclusion of the treatment by ointment one powders with a non-irritating powder, particularly in the places where articles of clothing might rub the skin. The Raderma salve according to *K. Hahn* (Med. Klinik, No. 44, 1930) is composed as follows: Adeps lanae anhydricus 34, Extractum aquosum et oleinicum Seminis Terminaliae, Folia psidi pyriformis, Radix Rumicis crispi ana 42, Vaselin 22, Ceresin 2. This salve is used prophylactically by x-ray specialists against injuries of irradiation.—Abs. *Ars. Medici,* **11:**1:32 (Jan.) 1931.

A Note on the Treatment of Erysipelas by X-Rays. R. Hillhouse Jamieson and F. Hernaman Johnson.

Brit. M. J. **1:***57 (Jan. 10) 1931.*

Three cases of facial erysipelas are reported. In one case, x-rays were not used. The infection ran a protracted course in which the temperature dropped by lysis. In the other two cases, x-rays were used and the temperature dropped by crisis within twelve hours. Small doses were given daily until the patient was cured. Even the hair and eyes can be exposed, for the doses are very small, not even approaching epilating doses.—Abs. *Arch. Derm. and Syph.,* **23:**5:969 (May) 1931.

Remarks on Bucky's Grenz Ray Treatment. Albert Bürkmann.

Dermat. Wchnschr. **92:***102 (Jan. 17) 1931.*

The "Mekapion" of Strauss is advised as a measuring instrument in giving treatments with Grenz rays in order to overcome the uncertainty of dosage that is otherwise inherent in the method. The author reports an unusual case in which 600 R caused an ulcerative reaction, though this dose is only two-thirds of that which ordinarily causes a mild erythema. He suggests hypersensibility to the soft rays as an explanation for this reaction.—Abs. *Arch. Derm. and Syph.,* **23:**5:978 (May) 1931.

Neue Kopfelektrode Fuer Die Diathermie. (A new head electrode for diathermy). F. Halla.

Med. Klinik, 1929. Ann. **25.** *Nr. 4. (Jan.) P. 153-54.*

For treatment of various portions of the skull by high frequency current or currents of other kinds the author uses an electrode carrier the shape of a metal brace similar to that in use for holding head-phones. Instead of telephone ear pieces, plate electrodes of various size can be attached. Also for fixation of metal olives to be introduced in the external auditory meatus, suitable attachments are suggested. A bandage serves for treatment of nose; it is put transversely round the skull and presses two small discoid electrodes against the external walls of the nose.

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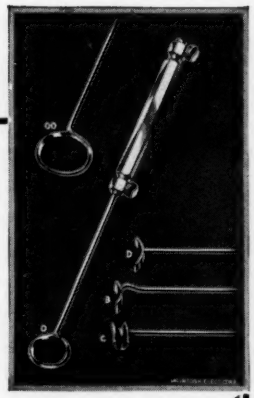

"O" and "OO," the ring instruments in the illustration, serve as indifferent electrodes and are used on prominent tonsils free from pillars. The inner portion of the ring is flat and smooth to evenly distribute the current. The rings are cut from tubes of Roman bronze and are fused to short rods. To facilitate placing the electrodes, the connections are offset.

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